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Momose et al.

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(54) **ILLUMINATING DEVICE, LIQUID CRYSTAL DISPLAY DEVICE, ELECTRONIC DEVICE, AND MANUFACTURING METHOD OF LIGHT GUIDE PANEL**

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G02F 1/1335 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 6/0036*** (2013.01); *G02B 6/0085* (2013.01); *G02F 1/133603* (2013.01); *G02B 6/0078* (2013.01); *G02F 1/133615* (2013.01); ***G02B 6/0065*** (2013.01); *G02B 6/0043* (2013.01); *G02B 6/009* (2013.01); *G02B 6/0068* (2013.01)
USPC **349/66**; 349/69

(58) **Field of Classification Search**
USPC 349/62, 65, 66
See application file for complete search history.

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(57) **ABSTRACT**

When first grooves are formed by irradiating a lower surface facing a light outgoing surface of a light guide plate for an illuminating device with laser beams, an outer circumferential region is firstly irradiated with the laser beams to form second grooves. Then, the second grooves are inspected. Next, irradiation conditions of the laser beams are adjusted based on an inspection result of the second grooves, irradiation positions of the laser beams are linearly displaced from formation positions of the second grooves, and formation of the first grooves in the scattering reflection region is then started.

21 Claims, 11 Drawing Sheets

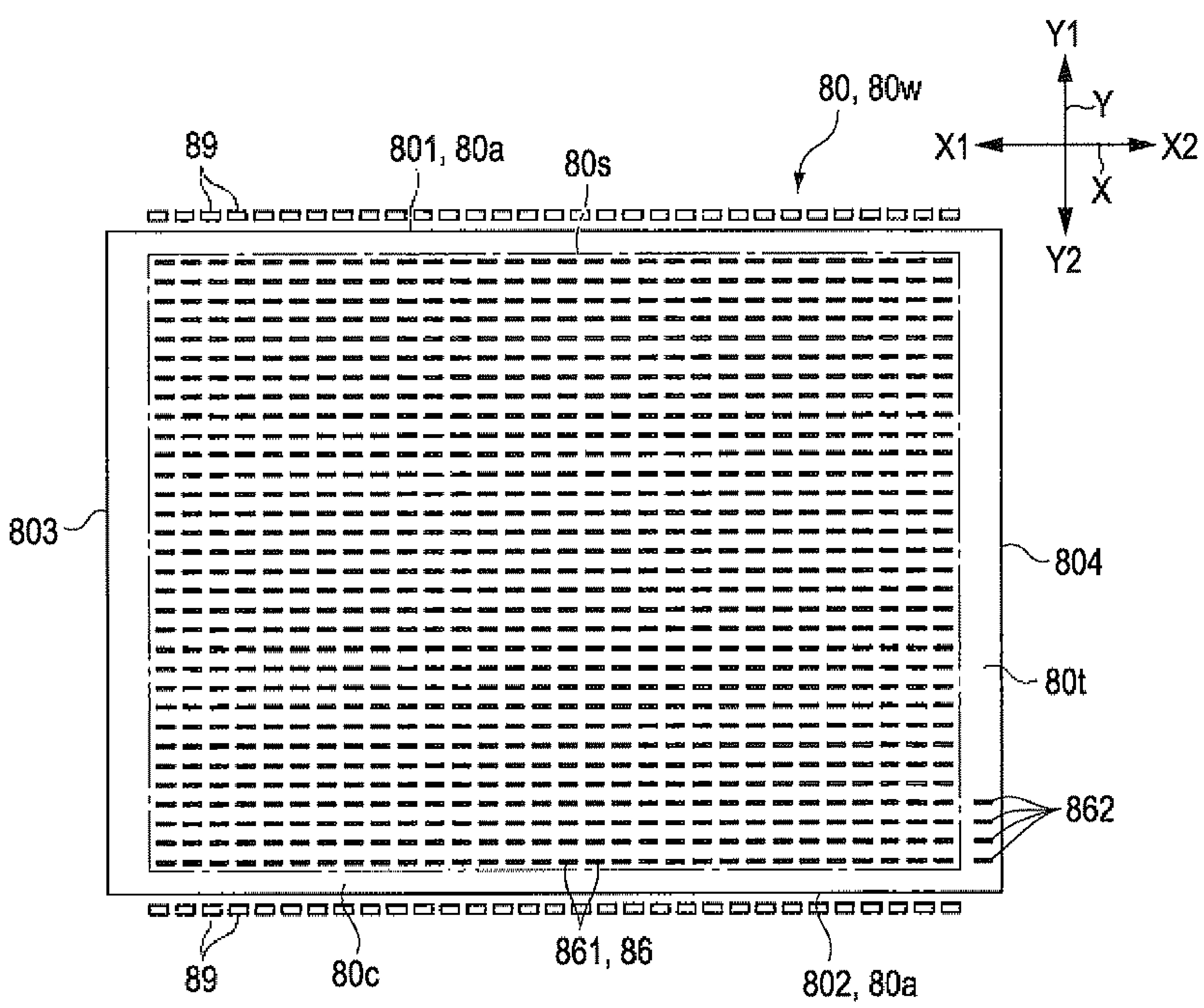


FIG. 1A

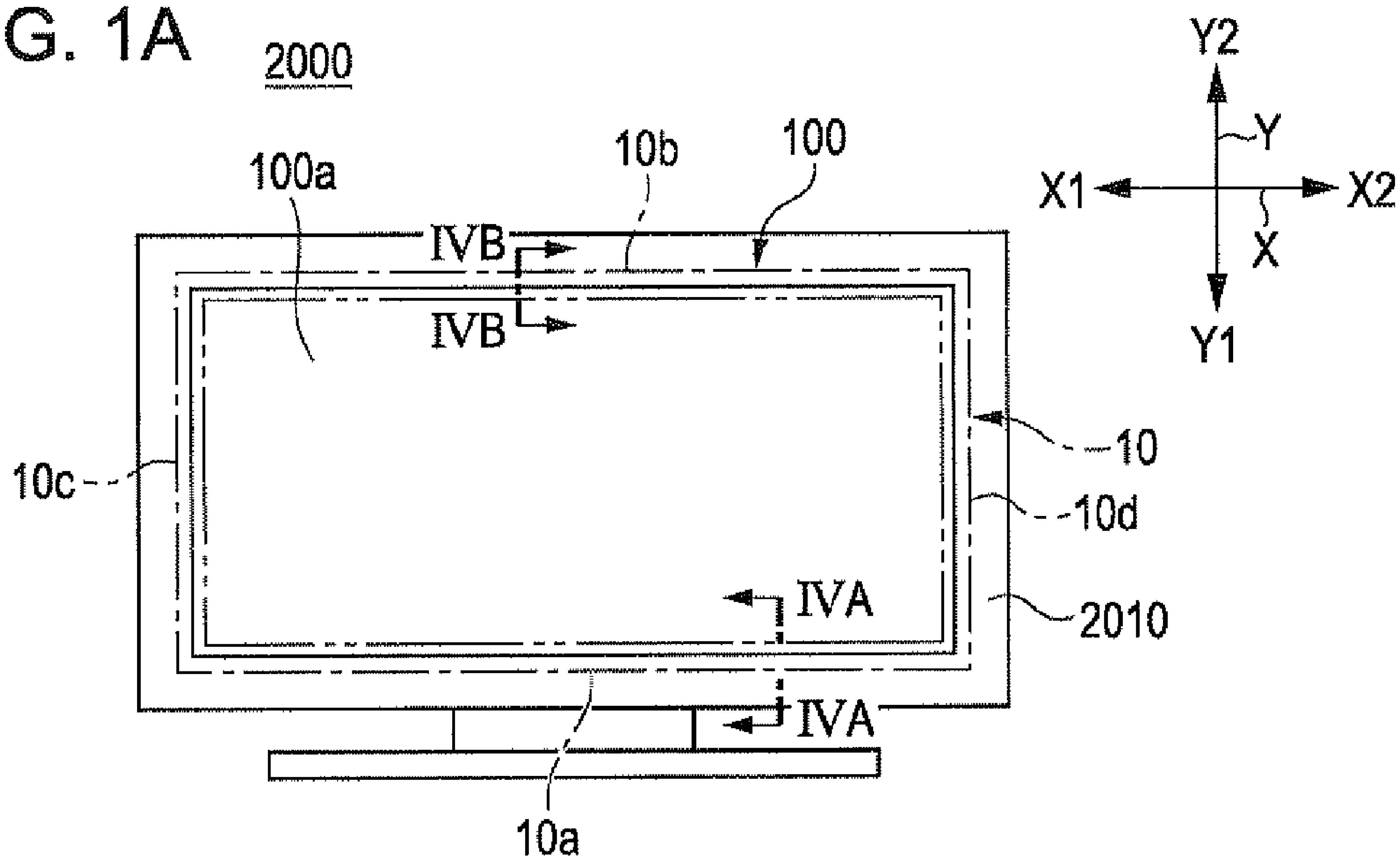

2000
100a
10b
100
IVB
IVB
Y2
Y
X1
X2
X
Y1
10c
10
10d
IVA
2010
IVA
10a

FIG. 1B

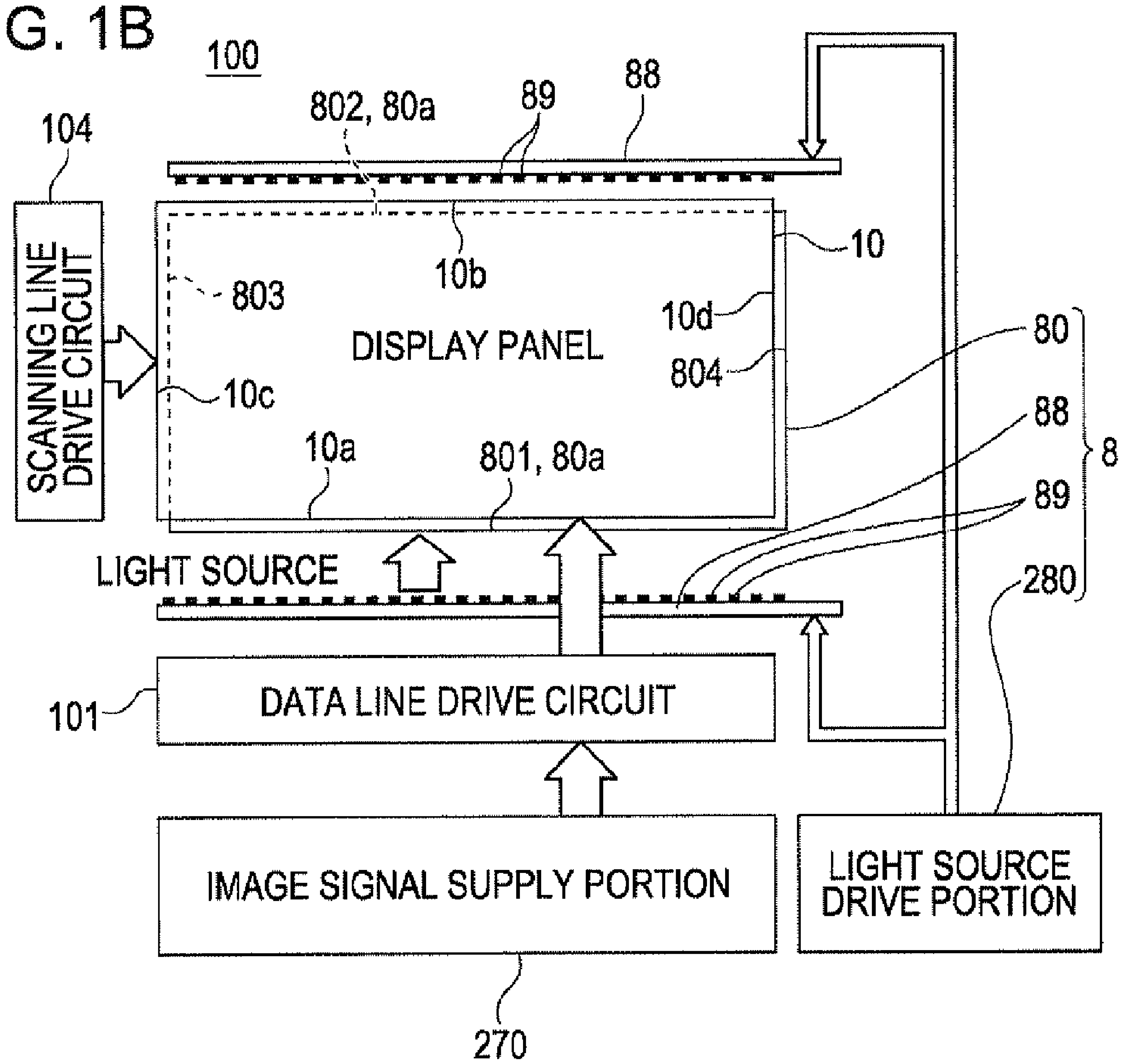

100
802, 80a
89
88
104
SCANNING LINE DRIVE CIRCUIT
803
10b
10
10d
DISPLAY PANEL
804
80
10c
88
8
10a
801, 80a
89
LIGHT SOURCE
280
101
DATA LINE DRIVE CIRCUIT
IMAGE SIGNAL SUPPLY PORTION
LIGHT SOURCE DRIVE PORTION
270

FIG. 2A

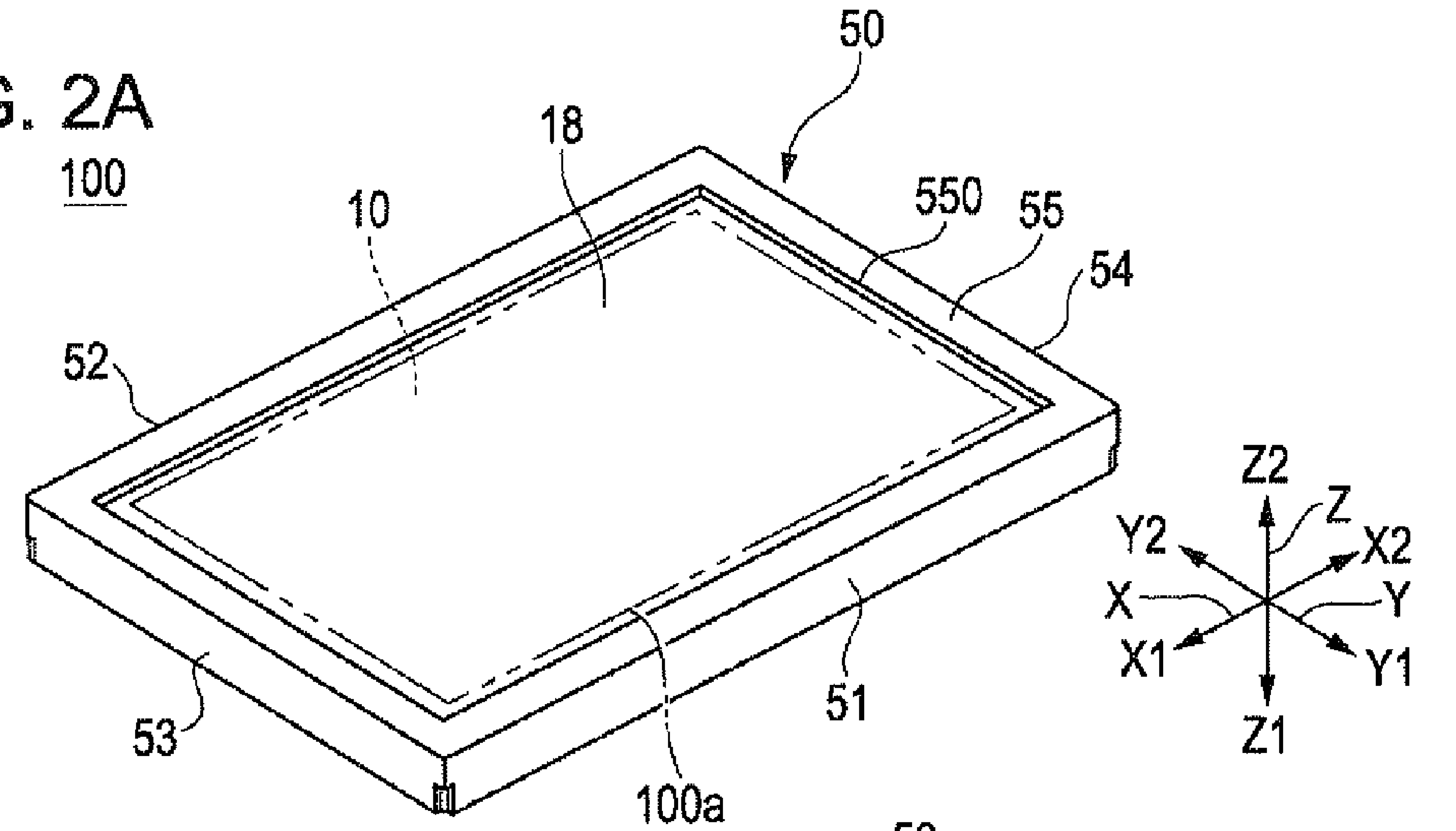

100
50
18
10
550
55
54
52
Z2
Z
Y2
X2
X
Y
X1
Y1
53
51
100a
Z1

FIG. 2B

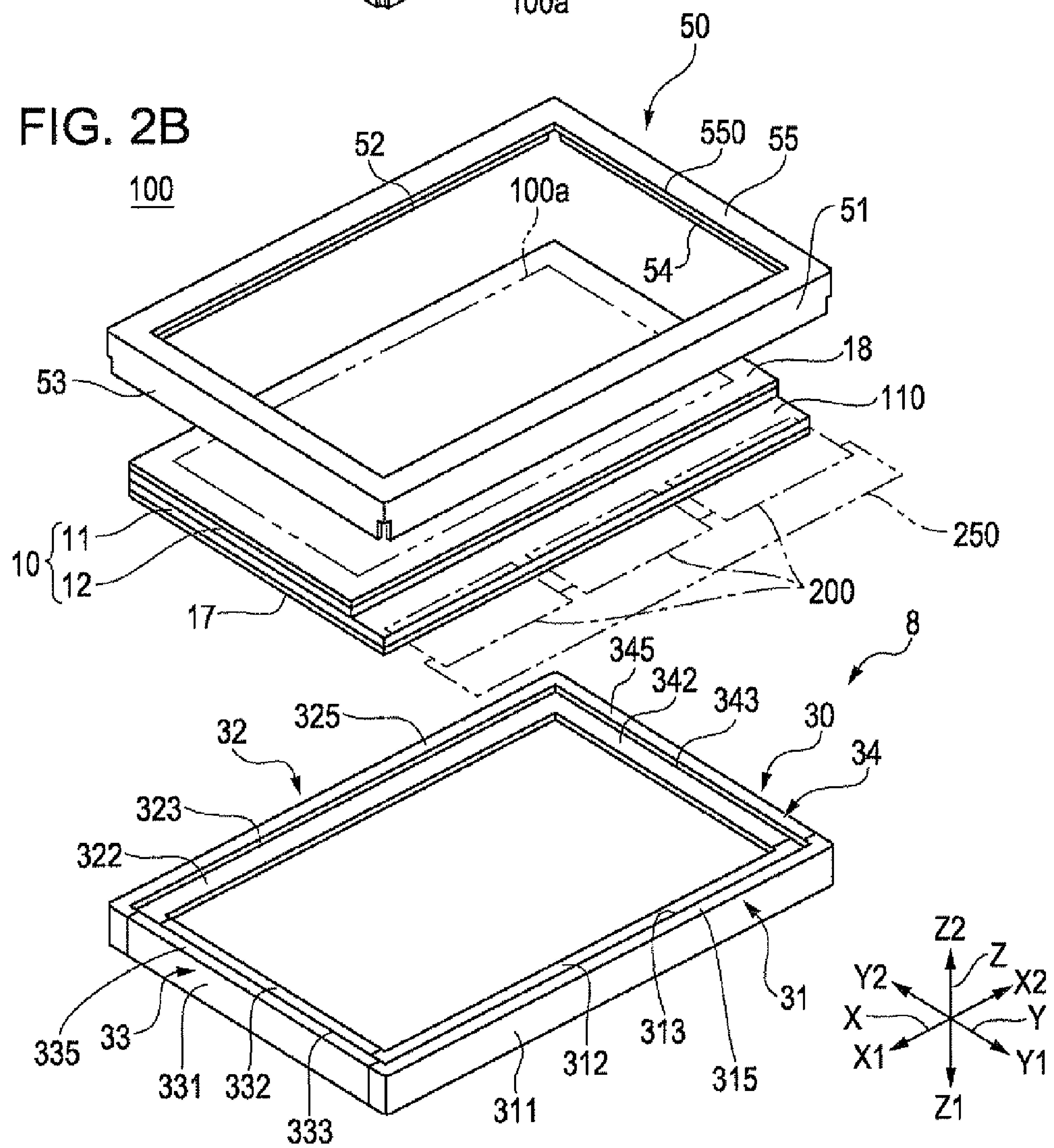
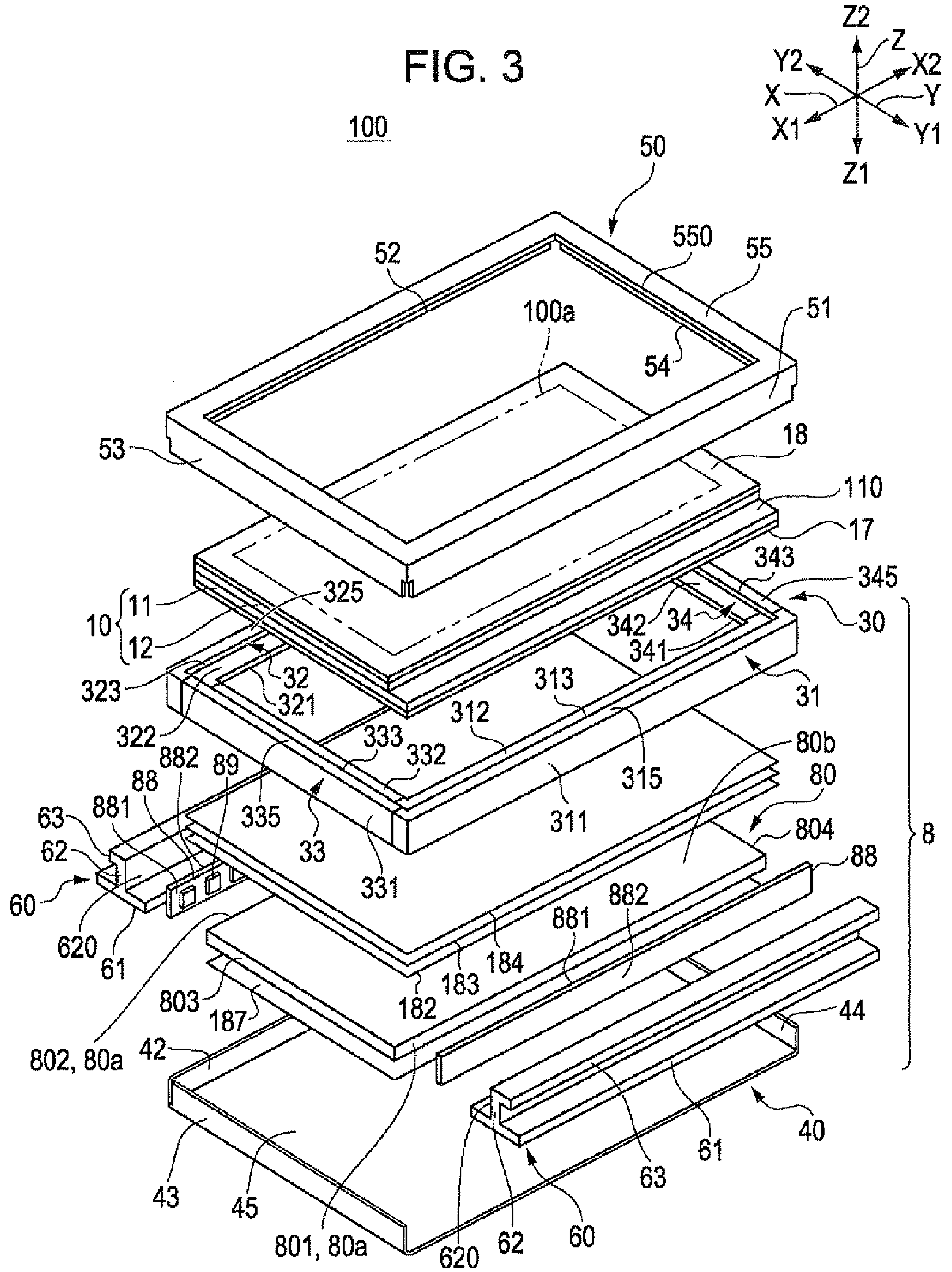

100
50
52
550
55
100a
51
54
53
18
110
250
10
11
12
17
200
8
345
342
343
325
32
30
34
323
322
Z2
Z
Y2
X2
X
Y
X1
Y1
Z1
335
33
331
332
333
311
312
313
315
31

FIG. 3



Z2
Z
Y2
X2
X
Y
X1
Y1
Z1
100
50
52
550
55
51
100a
54
53
18
110
17
343
345
10
11
12
325
342
34
341
30
323
32
321
322
313
31
312
333
332
315
882
89
88
80b
80
63
881
335
33
311
331
804
62
88
60
620
61
184
183
881
882
182
803
187
44
802, 80a
42
40
61
63
43
45
801, 80a
620
62
60
8

FIG. 4A

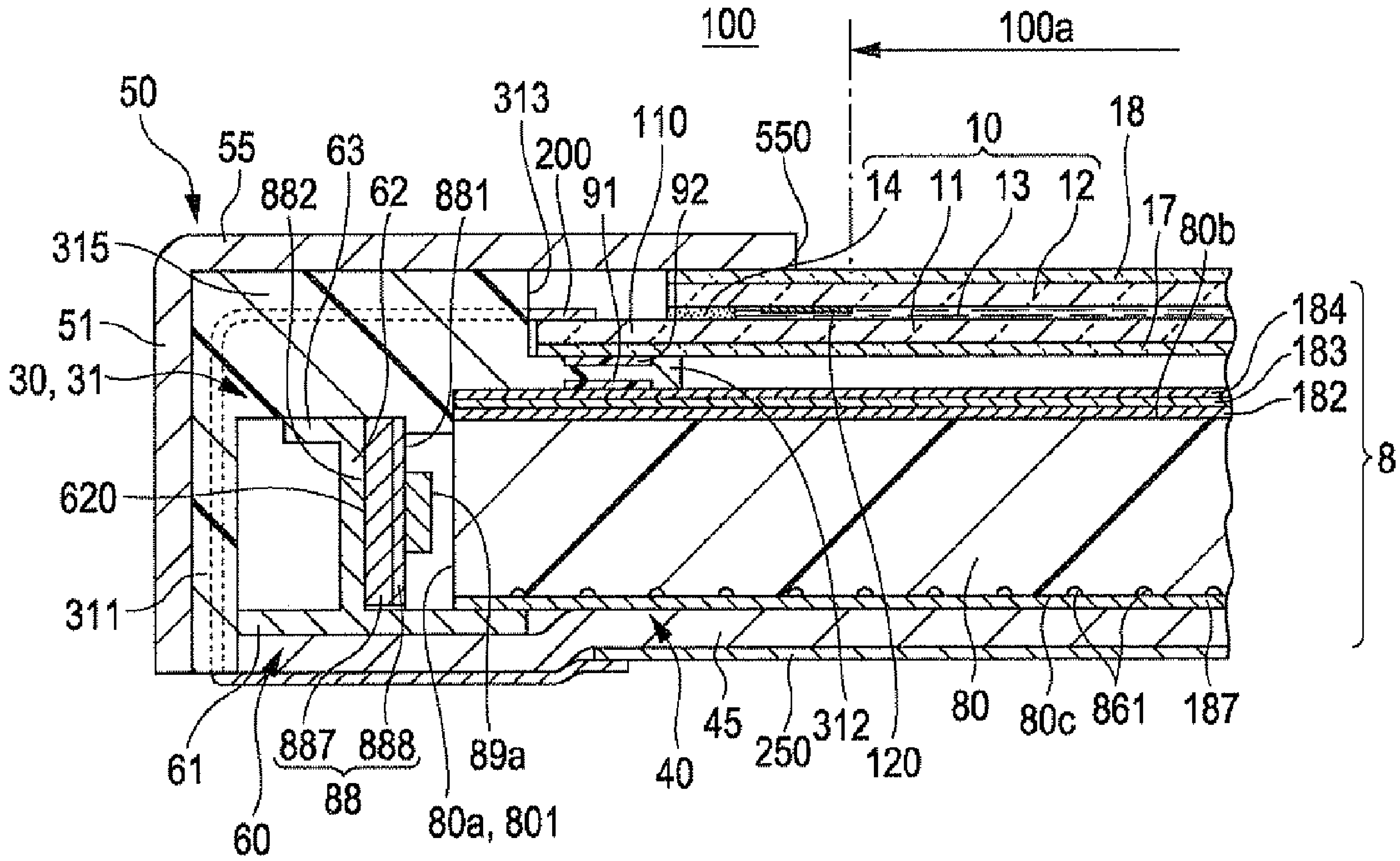

100
100a
50
55
63
882
62
881
313
200
110
91
92
550
10
14
11
13
12
18
17
80b
315
51
30, 31
620
311
184
183
182
8
61
60
887
888
88
89a
80a, 801
40
45
250
312
120
80
80c
861
187

FIG. 4B

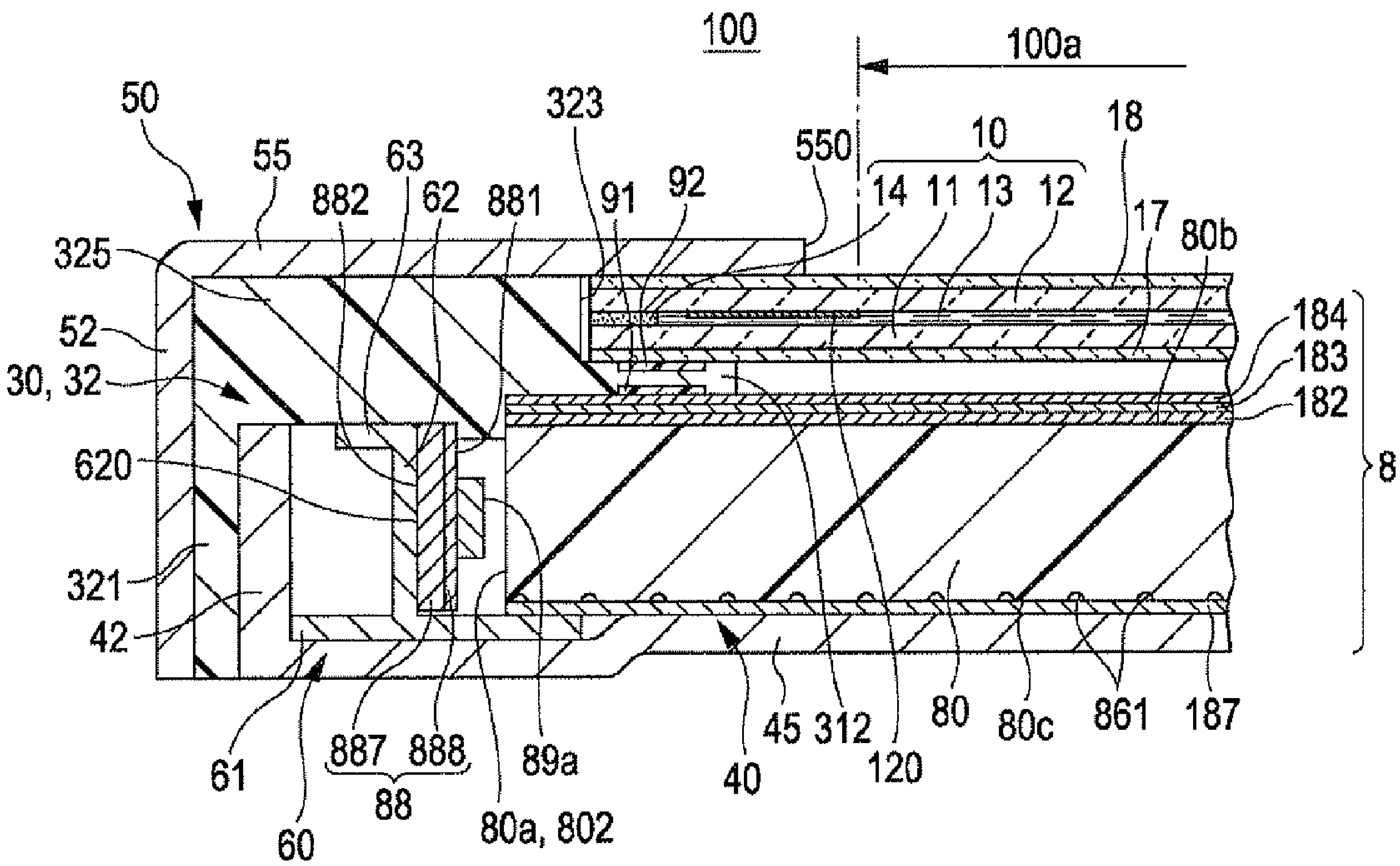
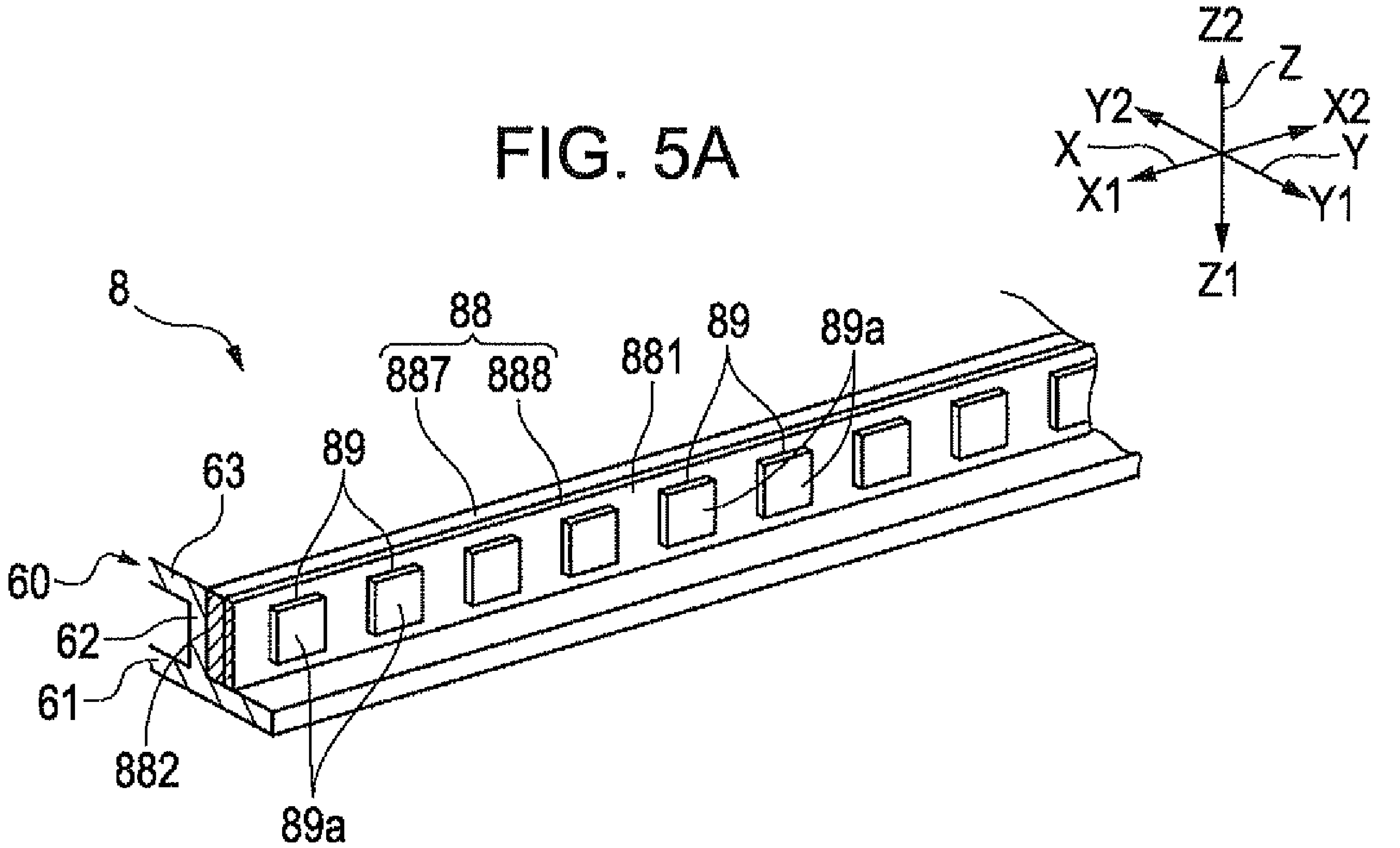
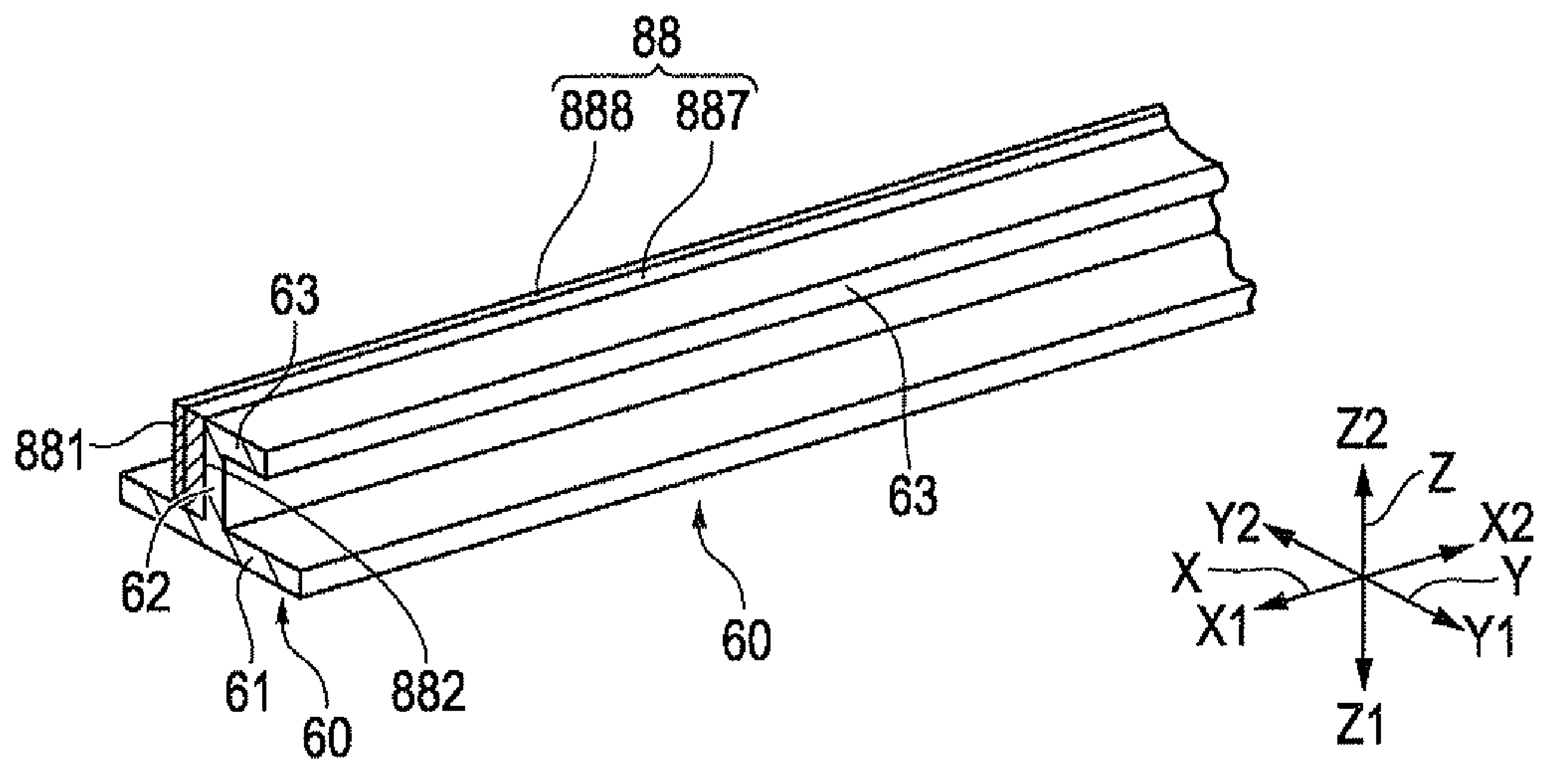

100
100a
50
55
63
882
62
881
323
91
92
550
10
14
11
13
12
18
17
80b
325
52
30, 32
620
321
42
184
183
182
8
61
60
887
888
88
89a
80a, 802
40
45
312
120
80
80c
861
187

FIG. 5A



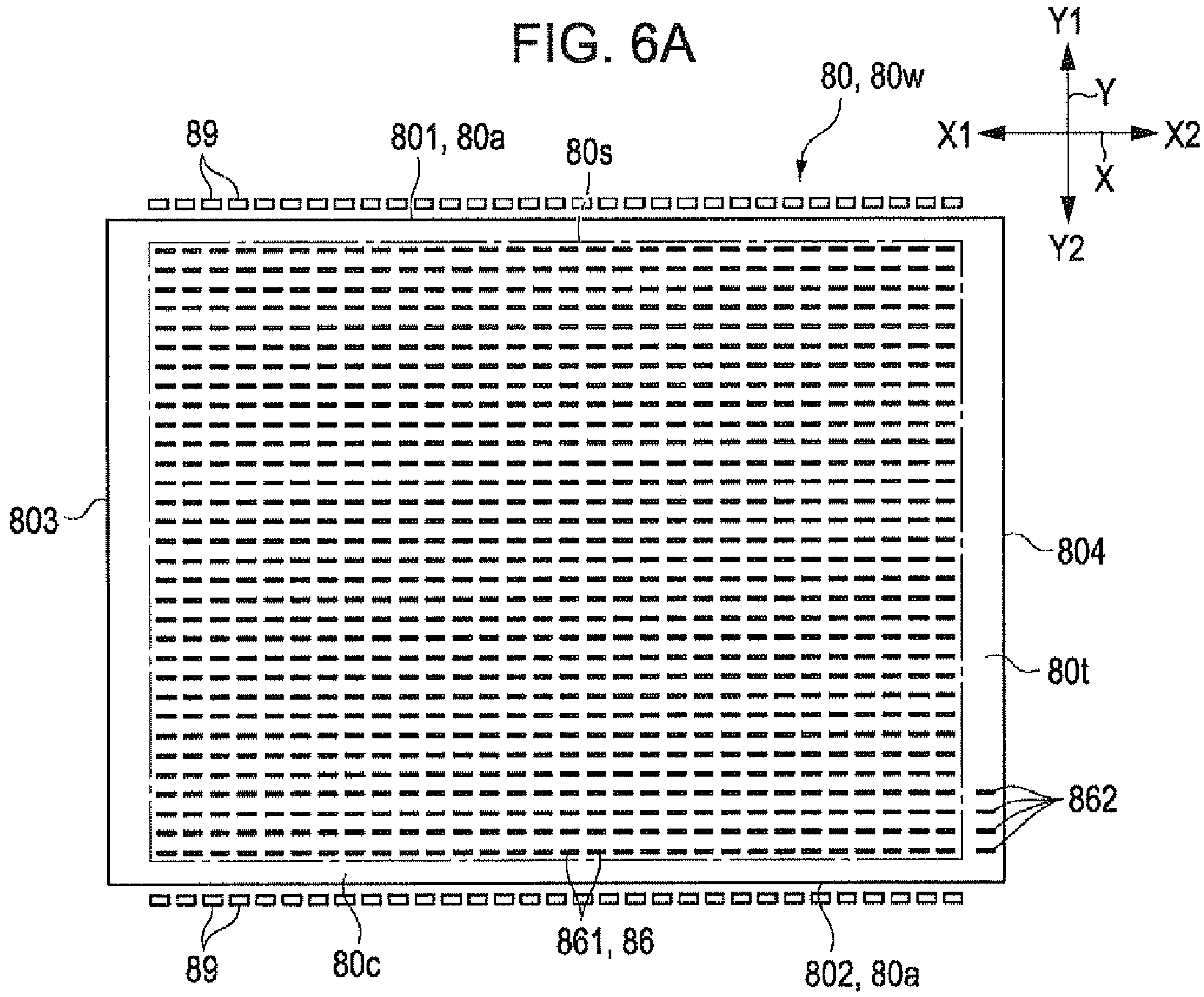
Z2
Z
Y2
X2
X
Y
X1
Y1
Z1
8
88
887
888
881
89
89a
63
89
60
62
61
882
89a

FIG. 5B



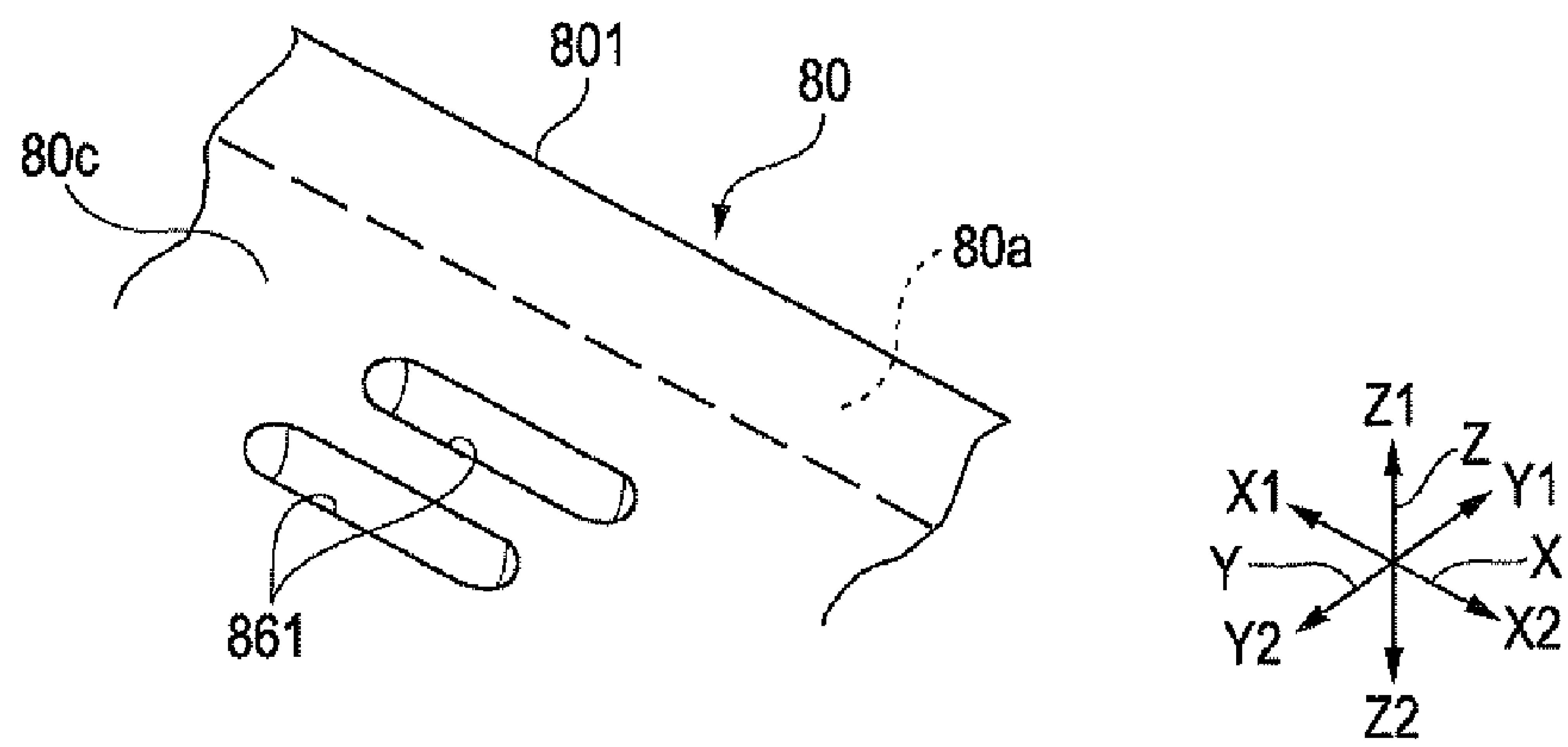
88
888
887
63
881
63
62
60
61
60
882
Z2
Z
Y2
X2
X
Y
X1
Y1
Z1

FIG. 6A



Y1
Y
X1
X2
X
Y2
80, 80w
89
801, 80a
80s
803
804
80t
862
89
80c
861, 86
802, 80a

FIG. 6B



801
80
80c
80a
861
Z1
Z
X1
Y1
Y
X
Y2
X2
Z2

FIG. 7A

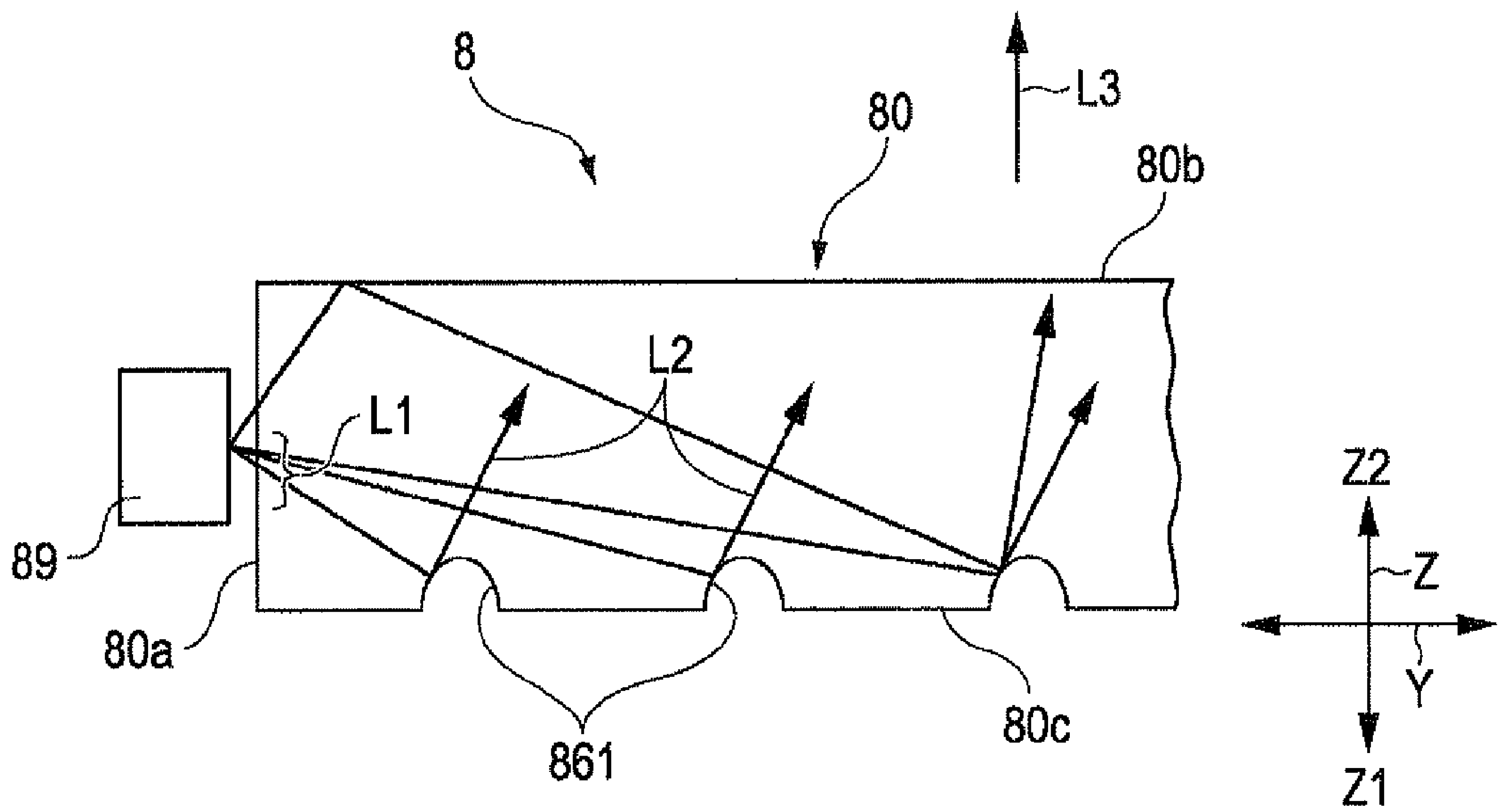

8
80
L3
80b
L2
L1
89
80a
861
80c
Z2
Z
Y
Z1

FIG. 7B

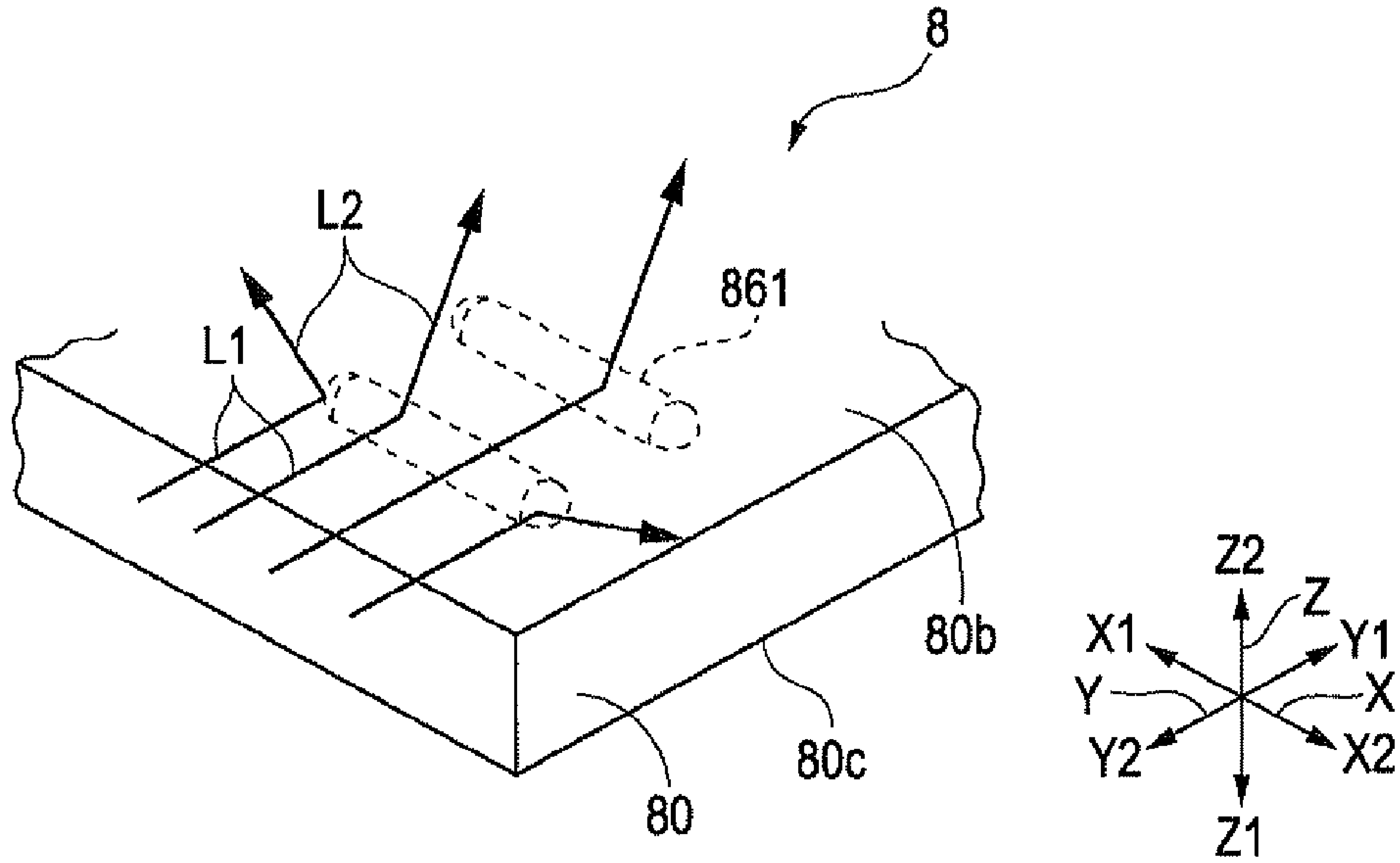
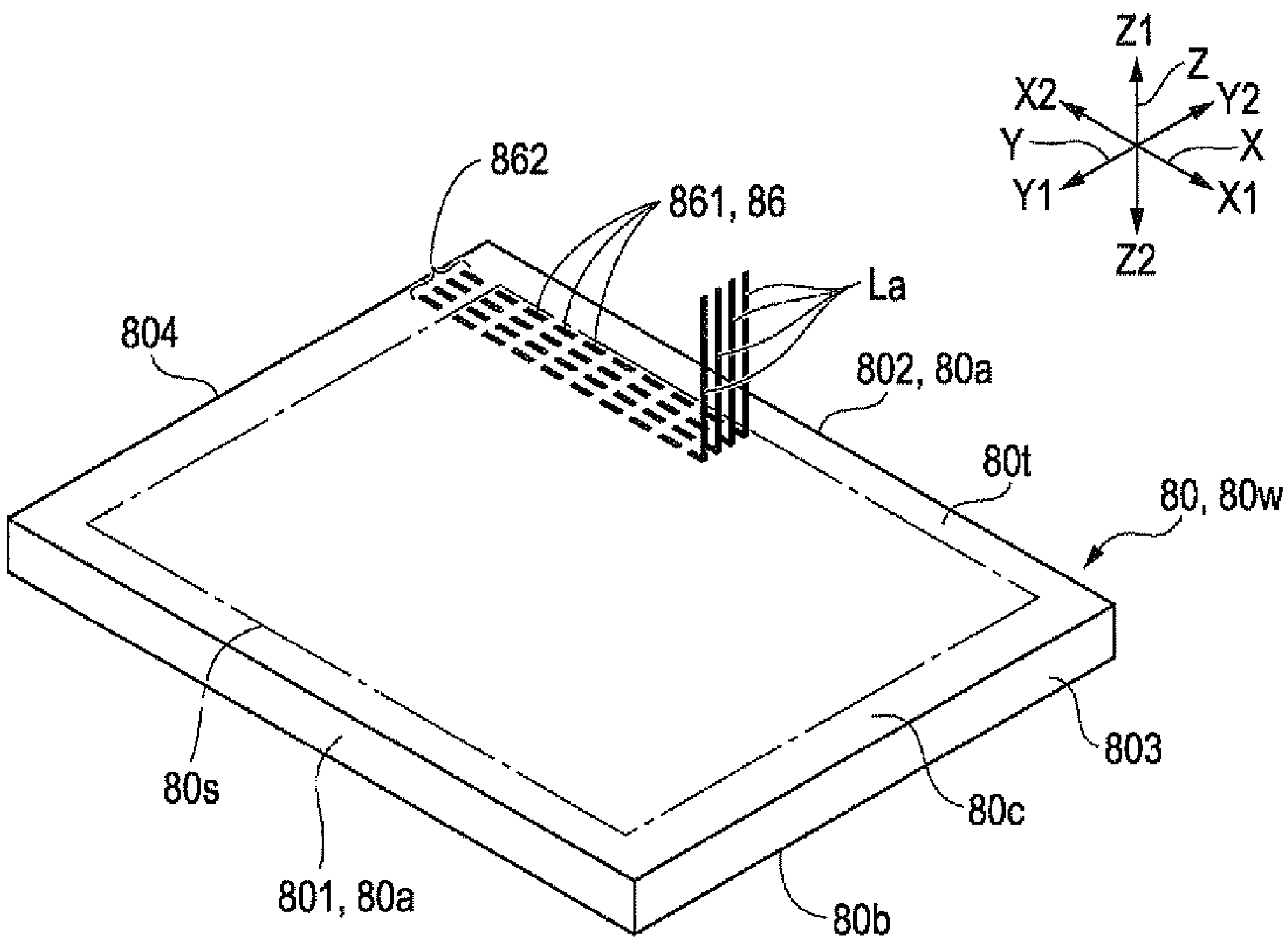

8
L2
861
L1
80b
80c
80
Z2
Z
X1
Y1
Y
X
Y2
X2
Z1

FIG. 8



Z1
Z
X2
Y2
Y
X
Y1
X1
Z2
862
861, 86
La
804
802, 80a
80t
80, 80w
803
80c
80s
801, 80a
80b

FIG. 9

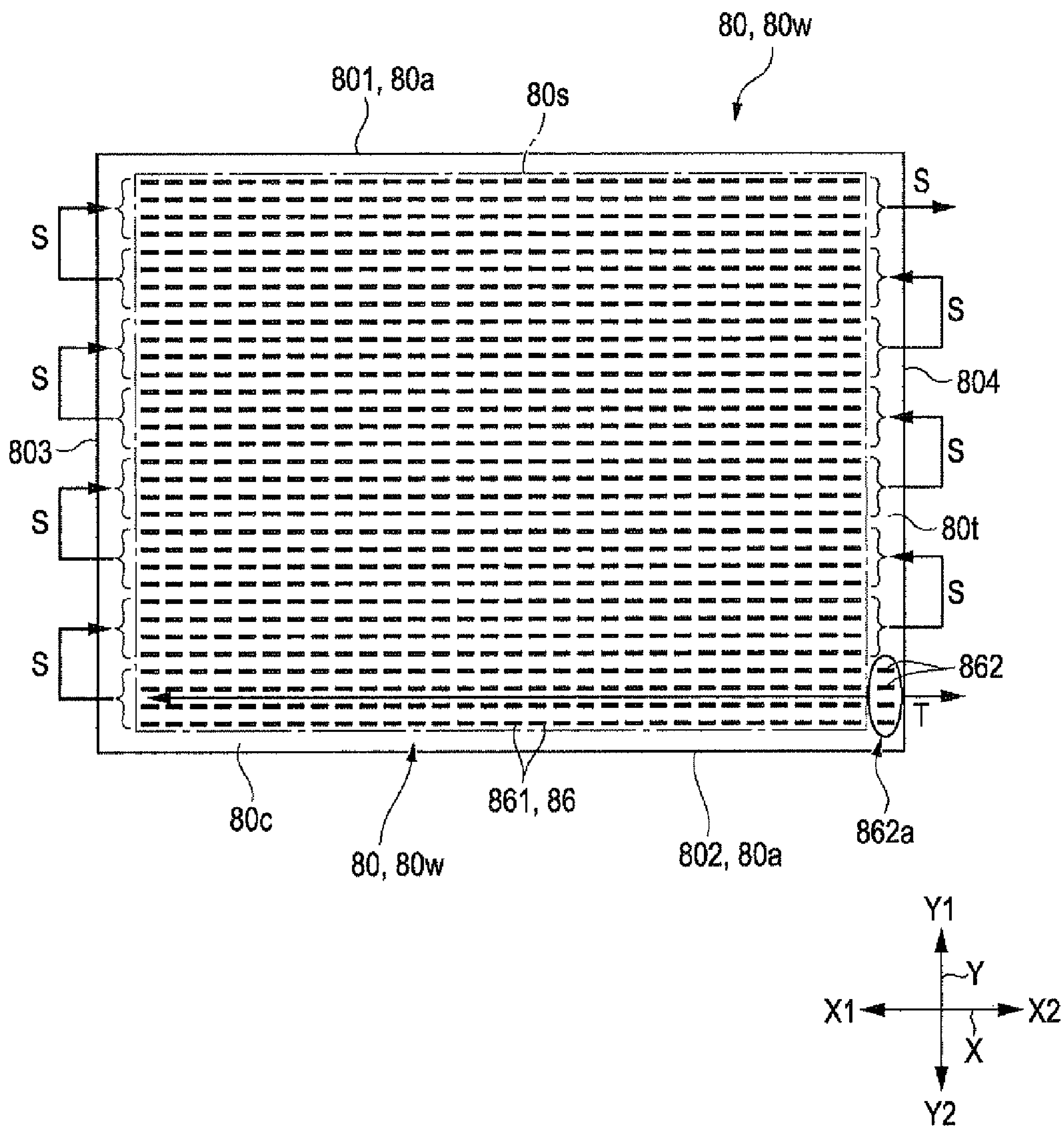

80, 80w
801, 80a
80s
S
S
S
S
S
S
S
S
S
804
803
80t
862
T
80c
861, 86
80, 80w
802, 80a
862a
Y1
Y
X1
X2
X
Y2

FIG. 10

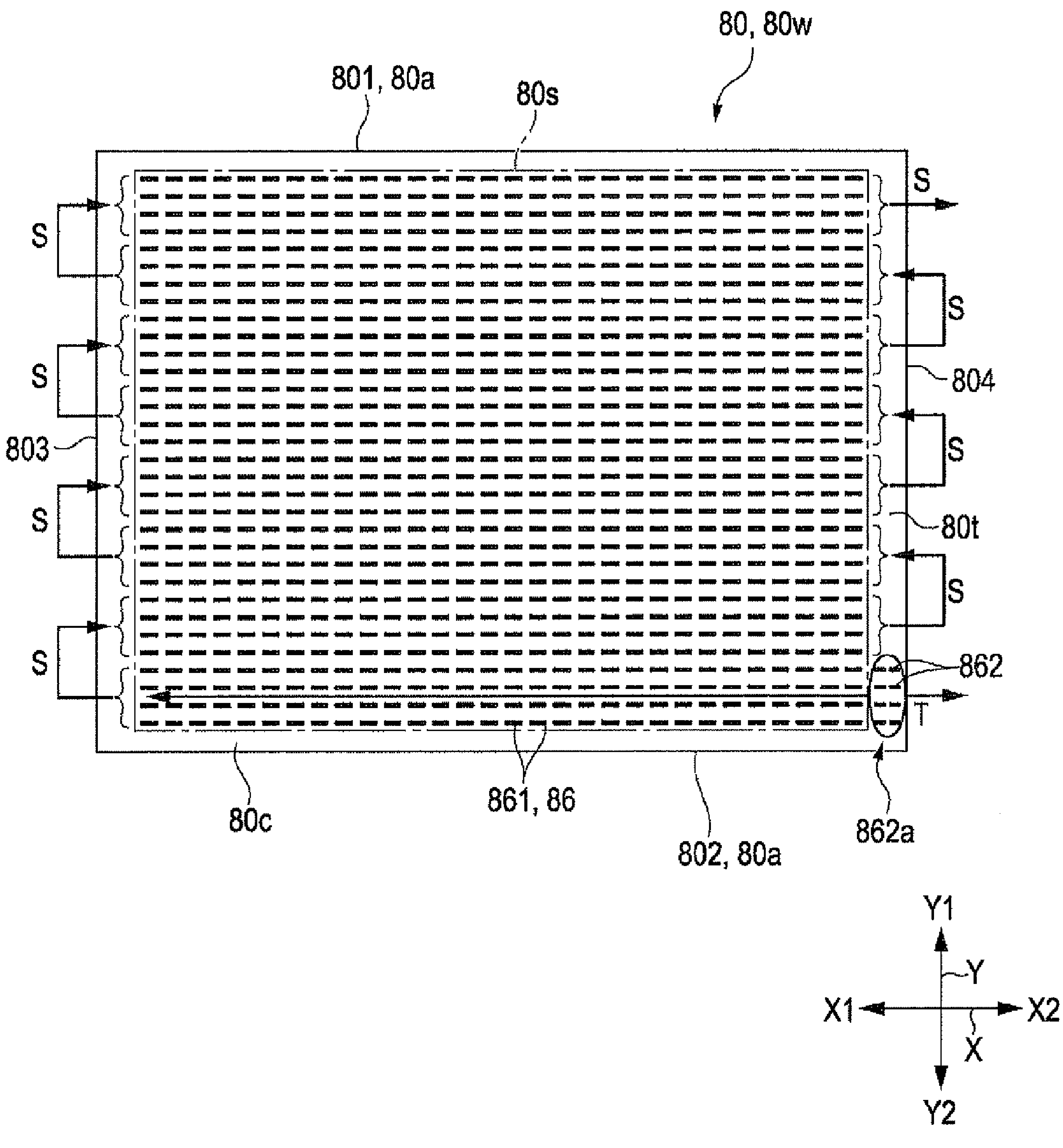
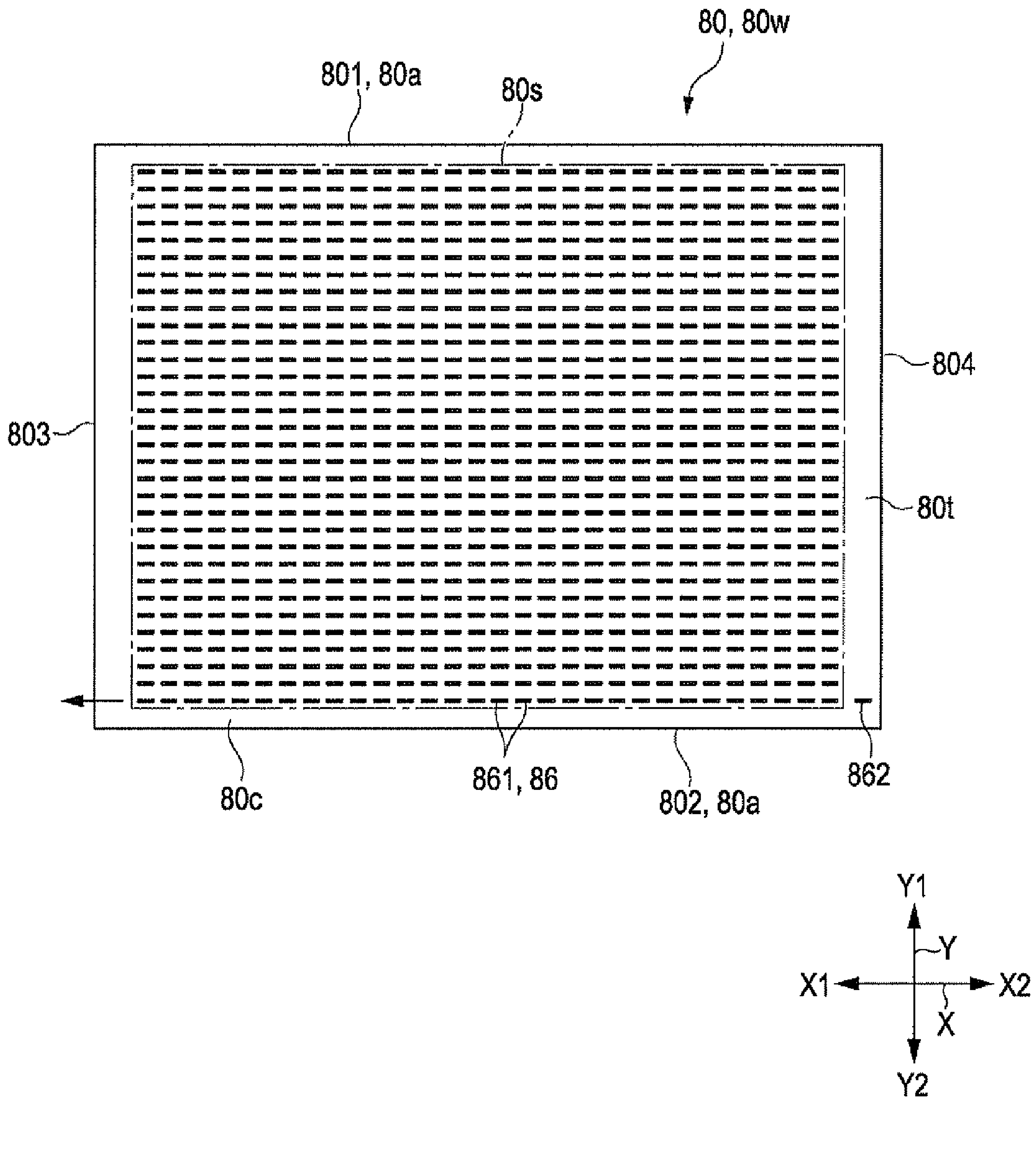

80, 80w
801, 80a
80s
S
S
S
S
S
S
S
S
S
804
803
80t
862
T
80c
861, 86
802, 80a
862a
Y1
Y
X1
X2
X
Y2

FIG. 11



80, 80w
801, 80a
80s
804
803
80t
80c
861, 86
802, 80a
862
Y1
Y
X1
X2
X
Y2

ILLUMINATING DEVICE, LIQUID CRYSTAL DISPLAY DEVICE, ELECTRONIC DEVICE, AND MANUFACTURING METHOD OF LIGHT GUIDE PANEL

BACKGROUND

1. Technical Field

The present invention relates to an illuminating device provided with a light guide plate and a light source, a liquid crystal display device provided with the illuminating device, an electronic device provided with the liquid crystal display device, and a manufacturing method of the light guide plate.

2. Related Art

A liquid crystal display device provided with a transmissive liquid crystal panel includes an illuminating device with a light source whose light emitting surface faces a side end surface as a light incident portion of a light guide plate, wherein a liquid crystal panel is arranged in a superimposed manner on a light outgoing surface side of the light guide plate. In relation to such an illuminating device, a configuration has been proposed in which a groove is formed with a laser beam on a surface opposite to the light incident surface in the light guide plate for the purpose of enhancing illumination light emitting intensity (see JP-A-2008-20888).

When a groove is formed with a laser beam as in JP-A-2008-20888, the light guide plate is displaced while the light guide plate is irradiated with a laser beam in a state where the light guide plate is placed on a stage. On this occasion, if a focus position of the laser beam is not precisely set on the surface of the light guide plate, sizes such as a plane area, and a depth of the groove are changed, and a quality of the light guide plate is varied.

However, the light guide plate is a translucent resin plate formed by molding, and therefore, the thickness is varied for each light guide plate. For this reason, there are problems in that a relationship between the surface of the light guide plate on the stage and a focus position of the laser beam is varied for each light guide plate when the light guide plate is irradiated with the laser beam, and that the quality of the light guide plate is varied.

SUMMARY

An advantage of some aspects of the invention is to provide an illuminating device in which a groove can appropriately be formed in a light guide plate, a liquid crystal display device provided with the illuminating device, an electronic device provided with the liquid crystal display device, and a manufacturing method of the light guide plate.

According to an aspect of the invention, there is provided an illuminating device including: a light guide plate which is provided with a light outgoing surface and side end surfaces; and light sources which are provided with light emitting surfaces facing the side end surfaces as light incident portions among the side end portions of the light guide plate, wherein an opposite surface facing the light outgoing surface of the light guide plate is provided with a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction are provided in a parallel manner in a second direction among the first and second directions intersecting in in-plane directions of the opposite surface and an outer circumferential region which is interposed between the scattering reflection region and end portions of the light guide plate, and wherein second grooves are provided on one side of extended lines of the groove arrays positioned on one end side in the second direction among the plurality of groove arrays.

According to another aspect of the invention, there is provided a manufacturing method of a light guide plate for an illuminating device, the method including for forming a plurality of groove arrays, which include a plurality of first grooves linearly aligned in a first direction, in a second direction among the first and second directions intersecting in an in-plane direction of an opposite surface by irradiating a scattering reflection region set in the opposite surface facing a light outgoing surface of the light guide plate with the laser beams: forming second grooves by irradiating an outer circumferential region in the opposite surface, which is interposed between the scattering reflection region and end portions of the light guide plate, with laser beams; and starting formation of the first grooves by linearly displacing irradiation positions of the laser beams from formation positions of the second grooves.

According to the invention, when the first grooves are formed by irradiating the opposite surface facing the light outgoing surface of the light guide plate with laser beams, the outer circumferential region interposed between the scattering reflection region and the end portions of the light guide plate is firstly irradiated with the laser beams to form the second grooves, and the second grooves are then inspected. Next, the irradiation conditions of the laser beams are adjusted based on the inspection result of the second grooves, and the formation of the first groove is started by linearly displacing the irradiation positions of the laser beams from the formation positions of the second grooves. For this reason, it is possible to form the first grooves with appropriate dimensions such as plane areas and depths even if the thickness and the like of the translucent resin panel used as the light guide plate vary. Accordingly, it is possible to enhance quality of the light guide plate.

In this case, it is preferable that the first grooves and the second grooves have longitudinal directions in the first direction. That is, it is preferable that both the first grooves and the second grooves have the same basic conditions for formation, such as a condition that the laser beams are displaced in the first direction for formation.

In this case, it is preferable that the plurality of second grooves be formed on extended lines of the groove arrays. With such a configuration, it is possible to perform inspection with the use of the plurality of second grooves formed on each extended line of the groove array. In addition, it is possible to determine optimal manufacturing conditions based on the inspection result of the second grooves if the plurality of second grooves are formed while the manufacturing conditions are changed.

In this case, it is possible to employ a configuration in which the second grooves are provided on each of the extended lines of the plurality of groove arrays positioned on one end side in the second direction among the plurality of groove arrays.

In this case, a configuration may also be employed in which the second groove is provided on an extended line of one groove array positioned on a side which is closest to the one end side in the second direction among the plurality of groove arrays.

In this case, it is preferable that each light incident portion be configured by a side end surface positioned in the second direction in the light guide plate. With such a configuration, no second grooves are provided on the side to which the light from the light source is incident, and therefore, unnecessary scattering reflection in the second groove does not occur.

According to still another aspect of the invention, there is provided a liquid crystal display device including: the illuminating device of the aspect of the invention; and a liquid crystal panel which is arranged so as to be overlapped on a light outgoing surface side of the light guide plate.

The liquid crystal display device according to an aspect of the invention is used in an electronic device such as a liquid crystal television.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIGS. **1**A and **1**B are explanatory diagrams of a liquid crystal television (electronic device) provided with a liquid crystal display device according to a first embodiment of the invention.

FIGS. **2**A and **2**B are explanatory diagrams showing an overall configuration of the liquid crystal display device according to the first embodiment of the invention.

FIG. **3** is an exploded perspective view of the liquid crystal display device according to the first embodiment of the invention when the liquid crystal display device is divided into smaller parts.

FIGS. **4**A and **4**B are cross-sectional views of the liquid crystal display device according to the first embodiment of the invention.

FIGS. **5**A and **5**B are explanatory diagrams showing a configuration around a light source substrate used in an illuminating device of the liquid crystal display device according to the first embodiment of the invention.

FIGS. **6**A and **6**B are explanatory diagrams of a light guide plate used in the illuminating device of the liquid crystal display device according to the first embodiment of the invention.

FIGS. **7**A and **7**B are explanatory diagrams of a first groove shown in FIGS. **6**A and **6**B.

FIG. **8** is an explanatory diagram showing a manufacturing method of the light guide plate shown in FIGS. **6**A and **6**B.

FIG. **9** is an explanatory diagram showing a state in which a laser beam is displaced when the light guide plate is manufactured based on a method shown in FIG. **8**.

FIG. **10** is an explanatory diagram of a light guide plate used in an illuminating device of a liquid crystal display device according to a second embodiment of the invention.

FIG. **11** is an explanatory diagram of a light guide plate used in an illuminating device of a liquid crystal display device according to a third embodiment of the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Referring the drawings, description will be given of embodiments according to which the invention is applied to a liquid crystal display device for a liquid crystal television. In addition, each layer and each member are shown with recognizable sizes in the drawings which will be referred to in the following description, and therefore, reduction scales are differently set for each layer and each member. Moreover, directions which intersect with each other in an in-plane direction of a light guide plate and a liquid crystal panel will be referred to as an X axis direction (first direction) and a Y axis direction (second direction), and a direction which intersects with the X axis direction and the Y axis direction will be referred to as a Z axis direction (third direction) in the following description. Furthermore, one side of the X axis direction will be referred to as an X**1** side, and the other side thereof will be referred to as an X**2** side. One side of the Y axis direction will be referred to as a Y**1** side, and the other side thereof will be referred to as a Y**2** side. One side of the Z axis direction will be referred to as a Z**1** side (lower side), and the other side thereof (aside from which illumination light and display light is emitted) will be referred to as a Z**2** side (upper side).

First Embodiment

Overall Configuration

FIGS. **1**A and **1**B are explanatory diagrams of a liquid crystal television (electronic device) provided with a liquid crystal display device according to a first embodiment of the invention. FIGS. **1**A and **1**B are an explanatory diagram schematically showing an appearance of a liquid crystal television and a block diagram showing an electric configuration of the liquid crystal display device, respectively.

An electronic device **2000** shown in FIG. **1**A is a liquid crystal television which includes a liquid crystal display device **100**, a frame **2010** for a television, and the like. The liquid crystal display device **100** includes a liquid crystal panel **10** which will be described later, an image signal supply portion **270** which supplies an image signal to the liquid crystal panel **10**, and an illuminating device **8** which supplies illumination light to the liquid crystal panel **10** described below. In addition, the liquid crystal display device **100** includes a scanning line drive circuit **104** which drives a scanning line extending in the axis direction in the liquid crystal panel **10** and a data line drive circuit **101** which drives a data line extending in the Y axis direction in the liquid crystal panel **10**. In relation to the scanning line drive circuit **104** and the data line drive circuit **101**, a configuration can be employed in which both are incorporated in the liquid crystal panel **10**. Moreover, it is also possible to employ a configuration in which one of the scanning line drive circuit **104** and the data line drive circuit **101** is incorporated in the liquid crystal panel **10** while the other is incorporated in an IC for driving which is separately provided from the liquid crystal panel **10** or a configuration in which both the scanning line drive circuit **104** and the data line drive circuit **101** are incorporated in the IC for driving which is separately provided from the liquid crystal panel **10**. As such an IC for driving, an IC mounted on a substrate configuring the liquid crystal panel **10** based on a COG mounting technology or an IC mounted on a circuit substrate (see FIGS. **2**A and **2**B) or the like electrically connected to the liquid crystal panel **10** is used.

According to this embodiment, an illuminating device **8** includes a light guide plate **80** arranged so as to be interposed on the liquid crystal panel **10**, a plurality of light emitting elements **89** arranged along side end surfaces, which are set as light incident portions **80**a among a plurality of side end surfaces of the light guide plate **80**, a light source substrate **88** on which the plurality of light emitting elements **89** are mounted, and a light source drive portion **280** which drives the light emitting elements **89**. In this embodiment, the liquid crystal panel **10** has a rectangular shape including four sides **10**a, **10**b, **10**c, and **10**d. Among the sides **10**a, **10**b, **10**c, and **10**d, the side **10**a is a long side positioned on the one side Y**1** in the Y axis direction, the side **10**b is a long side positioned on the other side Y**2** in the Y axis direction, the side **10**c is a short side positioned on the one side X**1** in the X axis direction, and the side **10**d is a short side positioned on the other side X**2** in the X axis direction. Corresponding to such a shape, the light guide plate **80** includes four side end surfaces **801**, **802**, **803**, and **804**. Among the side end surfaces **801**,

802, **803**, and **804**, the side end surfaces **801** is positioned at a long side of the one side **Y1** in the Y axis direction, the side end surface **802** is positioned at a long side of the other side **Y2** in the Y axis direction, the side end surface **803** is positioned at a short side on the one side **X1** in the X axis direction, and the side end surface **804** is positioned at a short side on the other side **X2** in the X axis direction. In this embodiment, the two side end surfaces **801** and **802** facing each other in a short side direction (Y axis direction) among the four side end surfaces **801**, **802**, **803**, and **804** of the light guide plate **80** configure the light incident portions **80***a*. For this reason, the light emitting elements **89** are aligned along the two side end surfaces **801** and **802** (light incident portions **80***a*) of the light guide plate **80**, and the substrates **88** for a light source extend along the two side end surfaces **801** and **802** (light incident portions **80***a*) of the light guide plate **80**.

Specific Configuration of Liquid Crystal Display Device **100**

FIGS. **2**A and **2**B are explanatory diagrams showing an overall configuration of the liquid crystal display device **100** according to the first embodiment of the invention. FIGS. **2**A and **2**B are a perspective view and an exploded perspective view of the liquid crystal display device **100**, respectively. FIG. **3** is an exploded perspective view of the liquid crystal display device **100** according to the first embodiment of the invention when the liquid crystal display device **100** is divided into further smaller components. FIGS. **4**A and **4**B are cross-sectional views of the liquid crystal display device **100** according to the first embodiment of the invention, and FIGS. **4**A and **4**B are a cross-sectional view of the liquid crystal display device **100** taken along a line IVA-IVA in FIG. **1**A and a cross-sectional view of the liquid crystal display device **100** taken along a line IVB-IVB in FIG. **1**A.

FIGS. **2**A, **2**B, **3**, **4**A, and **4**B, the liquid crystal display device **100** according to this embodiment is substantially provided with the illuminating device **8** which is a so-called back light apparatus and the transmissive liquid crystal panel **10** arranged so as to be superimposed on an upper surface of the illuminating device **8**. In the liquid crystal display device **100**, the illuminating device **8** is provided with a first frame **40** (lower metal frame) which is made of metal and arranged on the lower side (the one side Z**1** in the Z axis direction) so as to cover a rear surface of the light guide plate **80**, a second frame **30** (resin frame) which is made of resin so as to hold an end portion of the liquid crystal panel **10** on the upper side of the first frame **40** and surround and hold the illuminating device **8**, and a third frame **50** (upper metal frame) which is made of metal and arranged on the upper side (the other side Z**2** in the Z axis direction) of the second frame **30**.

The second frame **30** has a rectangular frame shape surrounding a circumference of the liquid crystal panel **10** and includes four frame plates **31**, **32**, **33**, and **34** which are divided corresponding to four sides of the liquid crystal panel **10** in this embodiment. According to this embodiment, a color of the second frame **30** is black, and the second frame **30** functions as a light absorption member to prevent stray light from being generated in the illuminating device **8**. The frame plates **31**, **32**, **33**, and **34** are respectively provided with side plate portions **311**, **321**, **331**, and **341** which extend downward on the side of an outer surface of the frame plates **31** to **34**, upper plate portions **315**, **325**, **335**, and **345** (end plate portions) which are bent from the upper end edges of the side plate portions **311**, **321**, **331**, and **341** toward the inside, and protruding plate portions **312**, **322**, **332**, and **342** which protrude inward from midway positions in height directions of the upper plate portions **315**, **325**, **335**, and **345**. For this reason, step portions **313**, **323**, **333**, and **343** are formed by the protruding plate portions **312**, **322**, **332**, and **342** inside the frame plates **31** to **34**, and the liquid crystal panel **10** is held by such step portions **313**, **323**, **333**, and **343** and the protruding plate portions **312**, **322**, **332**, and **342**. In addition, the light guide plate **80**, the light emitting elements **89**, and the like of the illuminating device **8** are arranged on the lower side of the protruding plate portions **312**, **322**, **332**, and **342**.

The first frame **40** is formed by press working on a thin metal plate such as an SUS plate. The first frame **40** is provided with a bottom plate portion **45** and three side plate portions **42** to **44** standing from three sides except for the one side **Y1** in the Y axis direction and has a rectangular box shape with an opened upper surface. The side plate portions **321**, **331**, and **341** of the second frame **30** are superimposed on the outside of the side plate portions **42** to **44** of the first frame **40**. In addition, the side plate portion **311** of the second frame **30** covers the one side **Y1** in the Y axis direction of the first frame **40**.

The third frame **50** is also formed by press working or the like on a thin metal plate such as an SUS plate in the same manner as in the first frame **40**. The third frame **50** is provided with a rectangular upper plate portion **55** (end plate portion) and four side plate portions **51** to **54** bent downward from the outer circumferential edge of the upper plate portion **55** and has a rectangular box shape with an opened lower surface. The side plate portions **51** to **54** are superimposed on the outside of the side plate portions **311**, **321**, **331**, and **341** of the second frame **30**. The upper plate portion **55** is formed with a rectangular window **550** from which light emitted from the liquid crystal panel **10** is emitted, and the upper plate portion **55** covers entire circumference of the outer circumferential end portion on the display light emitting side of the liquid crystal panel **10**. In addition, the upper plate portion **55** of the third frame **50** is provided so as to completely cover the upper sides of the upper plate portions **315**, **325**, **335**, and **345** (end plate portions) of the second frame **30**.

The third frame **50**, the second frame **30**, and the first frame **40** which are configured as described above are coupled to each other with bolts (not shown) or the like to hold the liquid crystal panel **10** and the illuminating device **8** inside. Here, flexible sheets **91** and **92** are adhered to the lower surfaces and the upper surfaces of the protruding plate portions **312**, **322**, **332**, and **342** of the second frame **30** as shown in FIGS. **4**A and **4**B. For this reason, the liquid crystal panel **10** is supported by the protruding plate portions **312**, **322**, **332**, and **342** via the flexible sheet **92** when the liquid crystal display device **100** is assembled. In addition, generation of floating and positional deviation of optical sheets (a diffusion sheet **182**, prism sheets **183** and **184**, and the like) in the illuminating device **8** is suppressed via the flexible sheet **91** when the liquid crystal display device **100** is assembled.

Configuration of Liquid Crystal Panel **10**

As shown in FIGS. **2**A, **2**B, **3**, **4**A, and **4**B, the liquid crystal panel **10** has a rectangular planar shape and is provided with an element substrate **11** on which pixel electrodes (not shown) are formed, a facing substrate **12** which are arranged so as to face the element substrate **11** with a predetermined interval, and a rectangular frame-shaped sealing member **14** which adheres the facing substrate **12** to the element substrate **11**. In such a liquid crystal panel **10**, a liquid crystal layer **13** is held in a region surrounded by the sealing member **14**. The element substrate **11** and the facing substrate **12** are made of translucent substrates such as glass substrates. On the element substrate **11**, a plurality of scanning lines (not shown) extend in the X axis direction, a plurality of data lines (not shown) extend in the Y axis direction, and switching elements (not shown) and pixel electrodes (not shown) are provided corresponding to intersections between the scanning lines and the data lines.

In this embodiment, the facing substrate **12** is arranged on the display light emitting side, and the element substrate **11** is arranged on the side of the illuminating device **8**. In addition, a surface of the facing substrate **12**, which faces the element substrate **11**, is formed with a frame edge layer **120** made of a rectangular light blocking layer along an inner edges of the four sides of the sealing member **14**, and a region defined by the inner edge of the frame edge layer **120** corresponds to an image display region **100***a*. Moreover, the inner edge of the upper plate portion **55** of the third frame **50** is at a midway position in the width direction of the frame edge layer **120**, and the window **550** of the third frame **50** is superimposed on the image display region **100***a* and the inner circumferential part of the frame edge layer **120**.

The liquid crystal panel **10** is configured as a liquid crystal panel based on a TN (Twisted Nematic) scheme, an ECB (Electrically Controlled Birefringence) scheme, or a VAN (Vertical Aligned Nematic) scheme, pixel electrodes are formed on the element substrate **11**, and a common electrode (not shown) is formed on the facing substrate **12**. In addition, when the liquid crystal panel **10** is a liquid crystal panel based on an IPS (In Plane Switching) scheme or an FFS (Fringe Field Switching) scheme, the common electrode is provided on the side of the element substrate **11**. In addition, the element substrate **11** is arranged on the display light emitting side with respect to the facing substrate **12** in some cases. An upper polarization plate **18** is arranged in a superimposed manner on the upper surface of the liquid crystal panel **10**, and a lower polarization plate **17** is arranged between the lower surface of the liquid crystal panel **10** and the illuminating device **8**.

In this embodiment, the element substrate **11** is larger than the facing substrate **12**. Therefore, the element substrate **11** includes a flange portion **110** extending from the end portion of the facing substrate **12**, and a plurality of flexible wiring substrates **200** are connected to the upper surface of such flange portion **110**. The flexible wiring substrates **200** are connected to a circuit substrate **250**, and the IC for control (not shown) configuring the image signal supply portion **270** described above with reference to FIGS. **1**A and **1**B and an IC for driving the light source (not shown) configuring the light source drive portion **280** are mounted on the flexible wiring substrates **200** or the circuit substrate **250**.

Configuration of Illuminating Device **8**

FIGS. **5**A and **5**B are explanatory diagrams showing a configuration around the light source substrate **88** used in the illuminating device **8** of the liquid crystal display device **100** according to the first embodiment of the invention, and FIGS. **5**A and **5**B are an explanatory diagram schematically showing a state on the side of one surface **881** of light source substrate **88** and an explanatory diagram schematically showing a state on the side of the other surface **882** of the light source substrate **88**, respectively. In addition, the configurations of the light emitting elements **89** and the light source substrates **88** arranged on the two side end surfaces **801** and **802** (light incident portion **80***a*) of the light guide plate **80**, which face each other in the Y axis direction, are the same. Accordingly, FIG. **5**A shows the light emitting elements **89** and the light source substrate **88** arranged on the side end surface **802** of the light guide plate **80**, and FIG. **5**B shows the light source substrate **88** and the like on the side end surface **801** of the light guide plate **80**.

As shown in FIGS. **3**, **4**A, and **4**B, the illuminating device **8** is provided with the light guide plate **80** arranged so as to be interposed on the lower surface side of the liquid crystal panel **10** and the plurality of light emitting elements **89** aligned from one end side (the one end side X1 in the X axis direction) of the light incident portions **80***a* toward the other end side (the other side X2 in the X axis direction) while the light emitting surfaces **89***a* are made to face the light incident portions **80***a* of the light guide plate **80**. In this embodiment, the plurality of light emitting elements **89** are mounted on the one surface **881** of the light source substrate **88** extending in the X axis direction along the light incident portions **80***a*. The light emitting elements **89** are LEDs (Light Emitting Diodes) emitting white light and emit light from the light source as diverging light.

In the illuminating device **8** according to this embodiment, the two side end surfaces **801** and **802** facing each other in the Y axis direction from among the side end surfaces **801**, **802**, **803**, and **804** of the light guide plate **80** are used as the light incident portion **80***a*. For this reason, the light emitting surface **89***a* are made to face the two light incident portions **80***a* (side end surfaces **801** and **802**) of the light guide plate **80**, and the plurality of light emitting element **89** are aligned from the one end side to the other end sire of each of the two light incident portions **80***a* (side end surfaces **801** and **802**). In addition, two light source substrates **88** extend along the two light incident portions **80***a* (side end surfaces **801** and **802**), and the plurality of light emitting elements **89** are mounted on the one surface **881** of each of the two the light source substrates **88**.

According to this embodiment, the light guide plate **80** is a translucent resin plate made of acrylic resin, polymethylstyrene resin, polycarbonate resin, or the like, and a reflective sheet **187** is disposed in a superimposed manner between a lower surface **80***c* of the light guide plate **80** (a surface which is opposite to a light outgoing surface **80***b*/an opposite surface) of the light guide plate **80** and a bottom plate portion **45** of the first frame **40**. The resin plate used as the light guide plate **80** is formed by extrusion molding, injection molding, or the like.

In addition, the optical sheets such as the diffusion sheet **182**, the prism sheets **183** and **184** are arranged in a superimposed manner between the upper surface (light outgoing surface **80***b*) of the light guide plate **80** and the liquid crystal panel **10**. The diffusion sheet **182** is a sheet provided with a coating layer in which silica particles or the like are dispersed in translucent resin such as acrylic resin or polycarbonate resin. According to this embodiment, the two prism sheets **183** and **184** are arranged such that both ridges perpendicularly intersect with each other. For this reason, the illumination light emitted from the light outgoing surface **80***b* of the light guide plate **80** is diffused in all directions by the diffusion sheet **182**, and a directional property that a peak is present in the front direction of the liquid crystal panel **10** is then given by the two prism sheets **183** and **184**.

As will be described later with reference to FIGS. **6**A, **6**B, and the like, a plurality of first grooves **861** configured by fine concave portions which linearly extend in the X axis direction (an alignment direction of the light emitting elements, which corresponds to a long side direction of the light guide plate and the liquid crystal panel) are formed in the lower surface **80***c* where the reflective sheet **187** is positioned, in the light guide plate **80**. According to this embodiment, a density of the first grooves **861** in the X axis direction (a direction in which the first grooves **861** linearly extend) is gradually increased in a direction away from the light emitting elements **89**. Therefore, the intensity distribution of the illumination light emitted from the light guide plate **80** is uniformized regardless of a distance from the light emitting elements **89**.

In the bottom plate portion **45** of the first frame **40**, steps are partially formed so as to secure a gap between the lower surface **80***c* of the light guide plate **80** and the first frame **40** in a region in a light guide plate **80**, which is overlapped with the side where the side end surfaces **801** and **802** as the light incident portions **80***a* are positioned, and the bottom plate portion **45** is bent toward the light guide plate **80**. In so doing, it is possible to pinch the reflective sheet **187** and the lower plate portion **61** of the light source supporting member **60** in a gap between the lower surface **80***c* of the light guide plate **80** and the bottom plate portion **45**. In addition, since a concave portion is formed on the rear surface side of the first frame **40** by partially bending the bottom plate portion **45** of the first frame **40** toward the light guide plate **80**, the flexible wiring substrate **200** is bent and made to extend up to the lower surface (rear surface) of the bottom plate portion **45** of the first frame **40**, and the circuit substrate **250** is arranged so as to be accommodated in such a concave portion. For this reason, it is possible to decrease the thickness of the illuminating device **8**.

According to this embodiment, the light source substrate **88** is arranged such that one surface **881** with the light emitting elements **89** mounted thereon faces the light incident portions **80***a* of the light guide plate **80**. In addition, the light source substrate **88** has a configuration in which a wiring pattern and a land are provided along with an insulating layer on the side of the one surface **881** of the plate-shaped metal plate **887** extending along the light incident portions **80***a*. Such configuration can be realized by attaching the flexible wiring substrate **888** obtained by integrating a resin base material layer, a wiring pattern, an insulation protecting layer, and the like in this order to the side of the one surface **881** of the metal plate **887**, for example. Accordingly, an insulation property is electrically secured between the metal plate **887** and the land on which the wiring pattern and the chips of the light emitting elements **89** are mounted. According to this embodiment, the metal plate **887** is made of an aluminum plate, and the metal plate **887** secures mechanical strength of the light source substrate **88** and also functions as a heatsink for the heat generated by the light emitting elements **89**.

As shown in FIGS. **3**, **4**A, **4**B, **5**A, and **5**B, to light source supporting members **60** for holding the light source substrate **88** are respectively provided on the sides of the other surfaces **882** of the two light source substrate **88**, and two light source supporting members **60** are held by the first frame **40** and the second frame **30**. According to this embodiment, the light source supporting members **60** are metal components with rod shapes extending along the other surfaces **882** of the light source substrates **88**, each of which has a lower plate portion **61** overlapped with the bottom plate portion **45** of the first frame **40** and a substrate supporting plate portion **62** protruding upward from a midway position in the width direction of the lower plate portion **61**. In addition, each of the light source supporting member **60** is provided with an upper plate portion **63** bent from the substrate supporting plate portion **62** to the side opposite to the side where the light guide plate **80** is positioned, and the upper plate portion **63** is fixed to the second frame **30** and the like by a screw or the like.

In the light source supporting member **60** with such a configuration, the surface of each substrate supporting plate portion **62**, in which the light guide plate **80** is positioned, is a substrate holding surface **620** for holding the light source substrate **88**, and the light source substrate **88** is fixed to the substrate holding surface **620** by a screw or the like. In such a state, the other surface **882** (metal plate **887**) of each light source substrate **88** is overlapped with the substrate holding surface **620** of the light source supporting member **60** in a plate contact state. In addition, the light source supporting member **60** is made of metal such as aluminum or iron-based metal. For this reason, the heat generated by the light emitting elements **89** is delivered from the metal plate **887** of the light source substrate **88** to the light source supporting member **60**, and the heat of the light source supporting member **60** is delivered to the first frame **40**. Therefore, it is possible to suppress temperature rising of the light emitting elements **89**.

Configuration of Light Guide Plate **80**

FIGS. **6**A and **6**B are explanatory diagrams of the light guide plate **80** used in the illuminating device **8** of the liquid crystal display device **100** according to the first embodiment of the invention, where FIG. **6**A is bottom view of the light guide plate **80** when viewed from the side of the lower surface **80***c* and FIG. **6**B is a perspective view of the first groove when viewed from the lower surface **80***c*. FIGS. **7**A and **7**B are explanatory diagrams of the first grooves **861** shown in FIGS. **6**A and **6**B, where FIG. **7**A is an explanatory diagram showing a state in which light is reflected by the first grooves **861** and FIG. **7**B is an explanatory diagram showing a direction in which the light is reflected by the first grooves **861**.

As shown in FIGS. **6**A and **6**B, a scattering reflection region **80***s* where the plurality of first grooves **861** are formed is set at the center of the lower surface **80***c* of the light guide plate **80**, and a gap between the scattering reflection region **80***s* and the end portion of the light guide plate **80** corresponds to an external circumferential region **80***t* where no first groove **861** is formed. The scattering reflection region **80***s* is a region from which the illumination light is emitted, which is overlapped with the image display region **100***a* of the liquid crystal panel **10**.

In the scattering reflection region **80***s*, a plurality of first grooves **861** are provided such that a plurality of groove arrays **86** linearly aligned in the X-axis direction is aligned in a parallel manner in the Y axis direction. According to this embodiment, the first grooves **861** are aligned at equal intervals in each groove array **86**. Accordingly, the plurality of first grooves **861** linearly extending in the X axis direction are arranged so as to intersect with the emitting direction of the light emitted from the light emitting elements **89**.

According to this embodiment, second grooves **862** which are formed based on the same manufacturing and working methods as those of the first grooves **861** are provided in the outer circumferential region **80***t* on the lower surface **80***c* of the light guide plate **80**. The second grooves **862** are provided on one side (the other side **X2** in the X axis direction) on extended lines of the groove arrays **86** positioned on the one end side (the end portion on the other side **Y2** in the Y axis direction) in the Y axis direction, among the plurality of groove arrays **86**. For this reason, the second grooves **862** are formed in a part interposed between the side end surface **804** which is not used as the light incident portion **80***a* in the light guide plate **80** and the scattering reflection region **80***s*, in the outer circumferential region **80***t*, and the positions are in a region near corners of the light guide plate **80** and the scattering reflection region **80***s*.

In addition, each of the second grooves **862** is provided on one side (the other side **X2** in the X axis direction) of each of the extended lines of the plurality of groove arrays **86** positioned on the one end side (the end portion on the other side **Y2** in the Y axis direction) in the Y axis direction among the plurality of groove arrays **86**. More specifically, the second grooves **862** are provided one by one on one side (the other side **X2** in the X axis direction) on the extended lines of four groove arrays **86** positioned on the one end side (the end portion on the other side **Y2** in the Y axis direction) in the Y axis direction among the plurality of groove array **86**, and the number of the second grooves **862** is four in total.

As shown in FIGS. **6**A, **6**B, **7**A, and **7**B, each of the first grooves **861** is constituted by a concave portion concaved in the lower surface **80***c* of the light guide plate **80**, which has a groove shape with a longitudinal direction in the X axis direction. A YZ cross-sectional surface of each first groove **861** has a substantially prism shape, and the bottom portion thereof has a semicircular shape with a radius at a curvature of about 30 μm to 80 μm. An opening width of each first groove **861** ranges from about 100 μm to 300 μm, for example, and an inclination angle of each side surface ranges from 30° to 55°. The second grooves **862** are for testing before the formation of the first grooves **861** and have the same configurations as those of the first grooves **861**.

According to the illuminating device **8** with such a configuration, the light emitted from the light emitting elements **89** is incident from the light incident portions **80***a* as shown by arrows L**1** and then advances through the inside of the light guide plate **80** while total reflection is repeated at the light outgoing surface **80***b* and the lower surface **80***c* inside the light guide plate **80**. Then, the light is reflected by the first grooves **861** as shown by arrows L**2**, and thereby the light is emitted as the illumination light from the light outgoing surface **80***b* as shown by an arrow L**3**. On this occasion, the light reflected by the end portions of the first grooves **861** advances while diffused and propagated in various directions, and thereby it is possible to enhance the uniformity of the illumination light emitted from the light outgoing surface **80***b* of the light guide plate **80**.

Manufacturing Method of Light Guide Plate **80**

FIG. **8** is an explanatory diagram showing a manufacturing method of the light guide plate **80** shown in FIGS. **6**A and **6**B. FIG. **9** is an explanatory diagram showing a state where laser beams are displaced for manufacturing the light guide plate **80** based on the method shown in FIG. **8**.

For manufacturing the light guide plate **80** as described above with reference to FIGS. **6**A, **6**B, **7**A, and **7**B, a resin plate **80***w* for the light guide plate is formed by extrusion molding or injection molding and then placed on an XY stage (not shown) such that one surface (the lower surface **80***c* of the light guide plate **80**) of the resin plate **80***w* faces upward, as shown in FIG. **8**. Then, the resin plate **80***w* is irradiated with laser beams La such as carbon dioxide lasers or femtosecond lasers, and a polymer material constituting the resin plate **80***w* is melted and volatilized at the irradiation positions thereby forming the first grooves **861**. According to this embodiment, four laser beams La are generated by the laser light emitted from a laser apparatus. That is, four laser beams are emitted from one head (omitted in the drawings).

According to this embodiment, while the four laser beams La are turned ON and OFF at predetermined timing, the resin plate **80***w* is displaced in the X axis direction, and the irradiation positions of the laser beams La are displaced in the X axis direction, as shown by arrows S in FIG. **9**, thereby simultaneously forming four groove arrays **86**. In addition, after the formation of the four groove arrays **86**, the resin plate **80***w* is displaced in the Y axis direction to newly form four groove arrays **86** at positions deviated in the one side Y**1** in the Y axis direction by an amount corresponding to four arrays with respect to the four groove arrays **86** previously formed. Such processes are repeated to form the first grooves **861** over the entirety of the scattering reflection region **80***s*.

When the light guide plate **80** is manufactured based on the above method, the light guide plate **80** may be degraded if sizes such as a plane area and a depth of each first groove **861** vary. Thus, a region surrounded by a circle **862***a* in FIG. **9** in the outer circumferential region **80***t* is irradiated with the laser beams La before the formation of the first grooves **861** to perform a second groove formation process for forming the second grooves **862**, according to this embodiment.

In the second groove formation process, the resin plate **80***w* is displaced in the X axis direction such that the positions at which the resin plate **80***w* is irradiated with the laser beams La are displaced from positions near the scattering reflection region **80***s* toward the end portion of the resin plate **80***w* as shown by an arrow T in FIG. **9**, for example. For forming the second grooves **862**, the resin plate **80***w* may be displaced in the X axis direction such that the positions at which the resin plate **80***w* is irradiated with the laser beams La are displaced from the side of the end portion of the resin plate **80***w* toward the position near the scattering reflection region **80***s*, in a direction opposite to the direction shown by the arrow T.

Next, an inspection process is performed for inspecting sizes (a length, a width, and a depth of each second groove **862**), a shape, and the like of each second groove **862**.

Next, a first groove formation process is performed for forming the first grooves **861**. In such a first groove formation process, irradiation conditions of the laser beams La is adjusted based on the inspection result in the inspection process, and the irradiation positions of the laser beams La are linearly displaced from the formation positions of the second grooves **862** to start the formation of the first grooves **861**. The irradiation conditions of the laser beams La include a focusing position of the laser beams La, timing of turning ON and OFF the power, and the like. In addition, a displacement speed of the resin plate **80***w* in the X axis direction for forming the first groove **861** is preferably the same as a displacement speed of the resin plate **80***w* in the X axis direction for forming the second grooves **862**.

Although the above description was given of a case in which the resin plate **80***w* (the light guide plate **80**) is displaced with respect to the head emitting the laser beams La to form the grooves (the first grooves **861** and the second grooves **862**), the head emitting the laser beams La may be displaced. In addition, both the head emitting the laser beams La and the resin plate **80***w* (light guide plate **80**) may be displaced.

Main Effects of the Embodiments

As described above, when the lower surface **80***c* (opposite surface) facing the light outgoing surface **80***b* of the light guide plate **80** is irradiated with the laser beams La to form the first grooves **861**, the outer circumferential region **80***t* is firstly irradiated with the laser beams La to form the second grooves **862**, and the second grooves **862** are then inspected, according to the embodiment. Next, the irradiation conditions of the laser beams La is adjusted based on the inspection result of the second grooves **862**, the irradiation positions of the laser beams La are linearly displaced from the formation positions of the second grooves **862**, and the formation of the first grooves **861** is started. Therefore, it is possible to form the first grooves **861** with appropriate dimensions such as plane areas and depths even if the thickness and the like of the resin plate **80***w* used in the light guide plate **80** vary. For this reason, it is possible to enhance the quality of the light guide plate **80**.

In addition, according to this embodiment, both the first grooves **861** and the second grooves **862** have longitudinal directions in the X axis direction. That is, the first grooves **861** and the second grooves **862** have the same basic conditions for formation such as a condition that the laser beams La are displaced in the X axis direction for forming both. For this reason, it is possible to appropriately form the first grooves

861 if the irradiation conditions of the laser beams La are adjusted based on the inspection result of the second grooves 862.

In addition, the light incident portions 80*a* are configured by the side end surfaces 801 and 802 positioned in the Y axis direction in the light guide plate 80, and no second groove 862 is provided on the side where the light is incident from the light emitting elements 89. Therefore, no unnecessary scattering reflection in the second grooves 862 occurs.

Second Embodiment

FIG. 10 is an explanatory diagram of a light guide plate 80 used in an illuminating device 8 of a liquid crystal display device 100 according to a second embodiment of the invention. In addition, since the basic configuration of this embodiment is the same as that in the first embodiment, same reference numerals are given to common components, and the description thereof will be omitted.

According to this embodiment, the outer circumferential region 80*t* is irradiated with the laser beams La to form the second grooves 862 in the same manner as in the first embodiment. According to such a manufacturing method, a plurality of second grooves 862 is formed on each of the extended lines of the four groove arrays 86 as shown in FIG. 10 in this embodiment while one second groove 862 is formed on each of the extended lines of the groove arrays 86 in the first embodiment. According to this embodiment, an example is shown in FIG. 10 in which two second grooves 862 are formed on each of the extended lines of the groove arrays 86, and the number of the second grooves 862 is eight in total.

According to such a configuration, the number of the second grooves 862 which can be used in the inspection is larger than that in the first embodiment, and therefore, it is possible to more precisely perform the inspection.

In addition, it is possible to set more appropriate conditions for determining optical manufacturing conditions based on the inspection result of the second grooves 862 if the irradiation conditions among the manufacturing conditions (laser beams La) are changed for each of the plurality of second grooves 862 formed on each of the extended lines of the groove arrays 86.

Third Embodiment

FIG. 11 is an explanatory diagram of a light guide plate 80 used in an illuminating device 8 for a liquid crystal display device 100 according to the third embodiment of the invention. In addition, since the basic configuration of this embodiment is the same as that in the first embodiment, same reference numerals are given to common components, and the description thereof will be omitted.

According to this embodiment, the irradiation of the laser beams La is performed in the same manner as in the first embodiment to form the first grooves 861 and the second groove 862. According to such a manufacturing method, the groove array 86 is formed one by one as shown in FIG. 11 in this embodiment while the four groove arrays 86 are simultaneously formed in the first and second embodiments. Therefore, the second groove 862 is formed only on the extended line of one groove array 86 positioned on the side which is the closest to the one end side (the side which is the closest to the other side Y2 in the Y axis direction) in the Y axis direction from among the plurality of groove arrays 86.

With such a configuration, the same effects as those in the first embodiment, such as an effect that the first grooves 861 can be formed after the adjustment of the irradiation conditions of the laser beams La based on the inspection result of the second grooves 862 and the like, can be achieved. In addition, this embodiment is employed when a method is employed in which a mirror is arranged in the course of optical paths of the laser beams La and the radiation positions of the laser beams La are displaced by switching the direction of the mirror.

Other Embodiments

Although a configuration in which the one surface 881 of each light source substrate 88 faces each light incident portion 80*a* of the light guide plate 80 is employed in the above first to third embodiments, the invention may be applied to the liquid crystal display device 100 with a configuration in which the one surface 881 of each light source substrate 88 perpendicularly intersects with each light incident portion 80*a* of the light guide plate 80. In addition, although both the side of the side end surface 801 of the light guide plate 80 and the side of the side end surface 802 of the light guide plate 80 are used as the light incident portions 80*a* in the above first to third embodiments, the invention may be applied to the liquid crystal display device 100 with a configuration in which only one of the side end surfaces 801 and 802 is used as the light incident portion 80*a*.

Moreover, according to the above first to third embodiments, four groove arrays 86 aligned in the Y axis direction at equal intervals are simultaneously formed by displacing the resin plate 80*w* in the X axis direction and displacing the irradiation positions of the laser beams La in the X axis direction, and after the formation of the four groove arrays 86, the resin plate 80*w* is displaced in the Y axis direction to newly form four groove arrays 86 at positions deviated in the one side Y1 in the Y axis direction by an amount corresponding to four arrays with respect to the four groove arrays 86 previously formed. However, it is possible to form the first grooves 861 at a predetermined density by adjusting the intervals of the four laser beams La and the displacement amount of the resin plate 80*w* in the Y axis direction.

Implementation Example in Electronic Device

Although the description was given of embodiments where a liquid crystal television is used as an electronic device 2000 on which the liquid crystal display device 100 is mounted, the liquid display device 100 to which the invention is applied may be used as a display of a personal computer, digital signage, or a display portion of an electronic device such as a car navigation device or a mobile information terminal.

The entire disclosure of Japanese Patent Application No.: 2011-157591, filed Jul. 19, 2011, 2011-253718, filed Nov. 21, 2011, and 2011-253719, filed Nov. 21, 2011 are expressly incorporated by reference herein.

What is claimed is:

1. A lighting device comprising:

a light guide plate having a first surface as a light emitting surface, a plurality of side surfaces and a second surface which opposed to the first surface of the light guide plate; and

a plurality of light emitting elements each of which has a light emission surface facing one of the plurality of side surfaces of the light guide plate,

wherein a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays being arranged in a parallel manner in a second direction intersecting the first direction in in-plane directions, the scattering reflection region provided on the second surface, wherein a peripheral region is provided on the second surface and between the scattering reflection region and edges of the plurality of side surfaces, the peripheral region being a non-light emitting region of the light guide plate, and

wherein a second groove is disposed on one side of an extended line of one of the plurality of groove arrays positioned on one end side in the second direction among the plurality of groove arrays and disposed in the peripheral region apart from the scattering reflection region.

2. The lighting device according to claim **1**,

wherein the first grooves and the second groove have longitudinal directions in the first direction.

3. The lighting device according to claim **1**,

wherein a third groove is provided on an extended line of one groove array positioned on a side which is closest to the one end side in the second direction among the plurality of groove arrays and on an extended line of the second groove.

4. The lighting device according to claim **1**,

wherein the one of the plurality of side surfaces is configured by a side surface positioned in the second direction in the light guide plate.

5. A liquid crystal display device comprising:

the lighting device according to claim **1**; and

a liquid crystal panel which is arranged so as to be overlapped on the first surface of the light guide plate.

6. A lighting device comprising:

a light guide plate having a first surface as light emitting surface, a plurality of side surfaces and a second surface which opposed to the first surface of the light guide plate; and

a plurality of light emitting elements each of which has a light emission surface facing one of the plurality of side surface of the light guide plate,

wherein a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays being arranged in a parallel manner in a second direction intersecting the first direction in in-plane directions, the scattering reflection region provided on the second surface,

wherein a peripheral region is provided on the second surface and between the scattering reflection region and edge of the plurality of side surfaces, the peripheral region being a non-light emitting region of the light guide plate, and

wherein second grooves are provided on one side of extended lines of the groove arrays positioned on one end side in the second direction among the plurality of groove arrays and disposed in the peripheral region apart from the scattering reflection region.

7. The lighting device according to claim **6**,

wherein the first grooves and the second grooves have longitudinal directions in the first direction.

8. The lighting device according to claim **6**,

wherein the third grooves are provided on an extended lines of one groove arrays positioned on a side which is closest to the one end side in the second direction among the plurality of groove arrays and on an extended line of the second grooves.

9. The lighting device according to claim **6**,

wherein the one of the plurality of side surfaces is configured by a side surface positioned in the second direction in the light guide plate.

10. A liquid crystal display device comprising:

the lighting device according to claim **6**; and

a liquid crystal panel which is arranged so as to be overlapped on the first surface of the light guide plate.

11. A manufacturing method of a light guide plate for an lighting device, the method comprising:

forming a second groove by irradiating laser beam on a peripheral region of a main surface of the light guide plate, the peripheral region provided between a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays arranged in a parallel manner in a second direction which intersects the first direction in in-plane directions and edges of the light guide plate, the peripheral region surrounding the scattering region on the main surface of the light guide plate;

starting formation of the first grooves which positioned on one end side in the second direction among the plurality of groove arrays by linearly displacing irradiation position of the laser beam from formation position of the second groove; and

inspecting the second groove after the forming of the second groove,

wherein the forming of the first grooves is performed after adjustment of irradiation conditions of the laser beams based on inspection results in the inspecting.

12. A manufacturing method of a light guide plate for an lighting device, the method comprising:

forming second grooves by irradiating laser beams on a peripheral region of a main surface of the light guide plate, the peripheral region provided between a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays arranged in a parallel manner in a second direction which intersects the first direction in in-plane directions and edges of the light guide plate, the peripheral region surrounding the scattering region on the main surface of the light guide plate;

starting formation of the first grooves which positioned on one end side in the second direction among the plurality of groove arrays by linearly displacing irradiation positions of the laser beams from formation position of the second grooves; and

inspecting the second grooves after the forming of the second grooves;

wherein the forming of the first grooves is performed after adjustment of irradiation conditions of the laser beams based on inspection results in the inspecting.

13. A light guide plate comprising:

a first main surface;

a second main surface; and

a first side surface,

a plurality of recesses being formed on the second main surface,

the plurality of recesses including a first recess and a plurality of second recesses,

the first recess being formed at a closest position from one side included in a plurality of sides constituting an outline of the second main surface,

the first recess being formed in a non-light emitting region of the light guide plate between one second recess of the plurality of second recesses that is formed at a first position closest to the first recess and the one side.

14. The light guide plate according to claim **13**,

the second main surface not having any recess between the first recess and one of the plurality of second recesses.

15. The light guide plate according to claim **13**,

further including a scattering reflection region in which a plurality of recesses arrays including the second recesses linearly disposing in a first direction are provided in a parallel manner in a second direction which intersecting the first direction in in-plane directions of the second main surface and the first recess is provided on an extended line of one of the plurality of second recess arrays positioned on a side which is closest to the one end side of the scattering reflection region.

16. A lighting device comprising:

the light guide plate according to claim **13**; and

a plurality of light emitting elements each of which has a light emission surface facing the first side surface.

17. A liquid crystal display device comprising:

the lighting device according to claim **16**; and

a liquid crystal panel which is arranged so as to be overlapped on the first main surface of the light guide plate.

18. An electronic device comprising:

the liquid crystal display device according to claim **17**.

19. A manufacturing method of a light guide plate for an lighting device, the method comprising:

forming a second groove by irradiating laser beam on a peripheral region of a main surface of the light guide plate, the peripheral region provided between a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays arranged in a parallel manner in a second direction which intersects the first direction in in-plane directions and edges of the light guide plate, the peripheral region being a non-light emitting region of the light guide plate surrounding the scattering region on the main surface of the light guide plate; and

starting formation of the first grooves which positioned on one end side in the second direction among the plurality of groove arrays by linearly displacing irradiation position of the laser beam from formation position of the second groove.

20. A lighting device comprising:

a light guide plate having a first surface as a light emitting surface, a plurality of side surfaces and a second surface which opposed to the first surface of the light guide plate; and

a plurality of light emitting elements each of which has a light emission surface facing one of the plurality of side surfaces of the light guide plate,

wherein a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays being arranged in a parallel manner in a second direction intersecting the first direction in in-plane directions, the scattering reflection region provided on the second surface,

wherein a peripheral region is provided on the second surface and between the scattering reflection region and edges of the plurality of side surfaces, and

wherein a second groove is disposed on one side of an extended line of one of the plurality of groove arrays positioned on one end side in the second direction among the plurality of groove arrays and disposed apart from the scattering reflection region, and no grooves are arranged in the peripheral region other than the second groove.

21. A lighting device comprising:

a light guide plate having a first surface as light emitting surface, a plurality of side surfaces and a second surface which opposed to the first surface of the light guide plate; and

a plurality of light emitting elements each of which has a light emission surface facing one of the plurality of side surface of the light guide plate,

wherein a scattering reflection region in which a plurality of groove arrays including a plurality of first grooves linearly extending in a first direction, the plurality of groove arrays being arranged in a parallel manner in a second direction intersecting the first direction in in-plane directions, the scattering reflection region provided on the second surface,

wherein a peripheral region is provided on the second surface and between the scattering reflection region and edge of the plurality of side surface, and

wherein second grooves are provided on one side of extended lines of the groove arrays positioned on one end side in the second direction among the plurality of groove arrays and disposed in the peripheral region apart from the scattering reflection region, and no grooves are arranged in the peripheral region other than the second groove.

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